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# From biosphere to noosphere: Vladimir Vernadsky's theoretical system as a conceptual framework for universal sustainability education

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FROM BIOSPHERE TO NOONSPHERE: VLADIMIR VERNADSKY'S  
THEORETICAL SYSTEM AS A CONCEPTUAL FRAMEWORK FOR UNIVERSAL  
SUSTAINABILITY EDUCATION

BY

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DISSERTATION

Submitted to the University of New Hampshire  
in Partial Fulfillment of  
the Requirements for the Degree of

Doctor of Philosophy  
in  
Natural Resources and Environmental Studies

May, 2010



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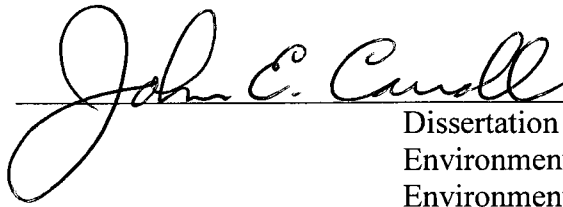
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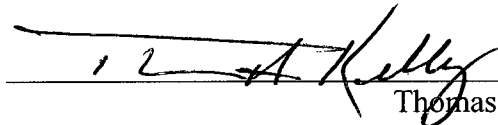
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Date

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## DEDICATION

*This work is lovingly dedicated with tremendous gratitude to my family and all those who have shown me what genuine values in life are, and that it is possible to live a simple but fulfilling life:*

*To my grandparents, babushka Tonya and dedushka Vasya, whose integrity and dignity early instilled in me both respect and compassion for others, and love and appreciation of nature;*

*To my parents, Nadezda and Lev, whose Russian names mean Hope and Lion, who raised my siblings and me with love, commitment, and enthusiasm, and whose infectious example, true values, and appreciation of the wonder of life made me who I am;*

*To my elder brother Alexander and younger sister Lena, with whom I shared a dream childhood, and from whom I have learned so much;*

*To my beloved daughters Elena, Antonina, and Elizaveta who have brought immeasurable love, joy, and happiness into my life; who have shared my obstacles and helped me not only to overcome but miraculously to transform life's trials into successes by being my inspiration and support; and whose understanding, patience, love, wisdom, and friendship I greatly appreciate;*

*To my beloved granddaughter Johanna and all children of today and to come who have already demonstrated a higher level of spirituality, mindfulness, and responsibility than previous generations did at the same early age, in the firm belief that they are indeed the world's rising Noospherians: citizens of the Earth who will consciously ensure balanced relationships within global society and between humans and the natural world;*

*To Hildegard and Heinz Pack, my dear German "parents," friends, and role models, whose large family lovingly accepted, inspired and supported me, with deep gratitude for their unconditional love, cheerfulness, humaneness, open-mindedness, and friendship that have had an indelible influence on my life;*

*To all my teachers, friends, and other acquaintance who have made an impression on my character and personality, my understanding and perspective on the world.*

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## **ABSTRACT**

# **FROM BIOSPHERE TO NOOSPHERE: VLADIMIR VERNADSKY'S THEORETICAL SYSTEM AS A CONCEPTUAL FRAMEWORK FOR UNIVERSAL SUSTAINABILITY EDUCATION**

by

Irina Trubetskova

University of New Hampshire, May, 2010

In light of accelerating global warming and climate change, the importance of sustainability education is unquestionable. It is a requirement of our time that sustainability education must become a part of any professional curriculum in higher education because today's college students are tomorrow's decision makers and the key players at local, national, and international levels.

Although the importance of education for a sustainable future has been recognized by the global community and we are now living through the United Nations Decade of Education for Sustainable Development (2005-2014), a common conceptual approach to teaching sustainability does not exist. We face a paradoxical situation. Students often are frustrated by information regarding the developing ecological crisis and feel hopeless about their uncertain future, while educators are not only confused by the overwhelming flow of information on sustainability and sustainable living but often are lost, trying to adapt multiple and various approaches to teaching sustainability.

The notion of sustainability education is still vague and indistinct due to its broad, multi- and interdisciplinary nature. Moreover, the name of Russian scientist Vladimir Vernadsky (1863-1945) – the author of the theory of the biosphere and the noosphere, which is a scientific foundation for Earth System Science and the concept of sustainability – is often unknown to many western educators. According to Vernadsky, the noosphere is a new evolutionary stage in the development of the biosphere when human-and-nature interaction will be consciously balanced.

Vernadsky's theory of the biosphere and the noosphere provides a solid scientific foundation for working out a conceptual approach to teaching sustainability. In our time of ecological challenges and uncertainty about the future, it is important to include Vernadsky's theory of the Biosphere and the Noosphere in sustainability education curricula because his concept carries an interdisciplinary and systems thinking approach, ecological and holistic worldview, and an optimistic vision of the future.

Using the Systems Thinking approach and based upon Vernadsky's original work, an extensive literature review, and the author's positive teaching experiences in applying Vernadsky's ideas to the teaching of sustainability, the present research shows that Vernadsky's theory of the biosphere and the noosphere represents a ready-to-use conceptual framework for universal sustainability education that can be effectively implemented by educators at all levels and in various settings.

*May, 2010.*

## INTRODUCTION

*I look forward with great optimism. I think that we undergo not only a historical, but a planetary change as well. We live in a transition to noosphere.*

Vladimir Vernadsky, 1945

*In the end we will conserve only what we love. We love only what we understand. We will understand only what we are taught.*

Baba Dioum, 1968

*The survival of the planet depends on whether future generations can be educated in ecological literacy – an awareness of the interconnectedness of all life. Such an education requires changes in many of our present assumptions about schooling.*

David Orr (1989)

June 23, 1988... James Hansen, a NASA scientist, testified before Congress that he was 99% confident that “the greenhouse effect has been detected, and it is changing our climate now” (Statement, 1988, quoted in Layzer, 2006). The same year the Intergovernmental Panel on Climate Change (IPCC, 1988) was created by the United Nations and 2,000 leading experts from all over the world started their work in order to understand “the scientific basis of risk of human-induced climate change.” Although during the following years “the IPCC has reported with increasing certainty that man-made emissions of greenhouse gases are causing rapid and potentially damaging changes in the global climate” (IPCC Assessment Report, 1990, 1995, 2001; Lazer, 2006), there was an intense scientific and political debate whether this was true. But now the denial is over. On February 3, 2007, the IPCC released its latest report, which is the result of six years of work by the 2,500 scientific expert reviewers, 800 contributing and 450 lead

authors from 130 countries. The report provides *unequivocal* scientific evidence of human-induced global warming, and analyzes its causes and possible consequences (IPCC Report Summary, 2007). This means that from now on the debate on this topic is shifted from “Does global warming and climate change really occur?” to its inevitable and harmful consequences and questions like “Is it not too late to do something about it?”

Indeed, even if we stop all CO<sub>2</sub> emissions right now, global warming will continue for the next 100 years (IPCC 2007), resulting in an increased number and intensity of such disastrous events as hurricanes, floods, heat waves, droughts, water and food shortages, and infectious diseases. It is essential to recognize that all of these problems are not just “environmental issues” but very serious homeland and global security issues. For example, even one of the projected problems alone – sea level rise – would make many millions of people ecological refugees because more than a half of the world's population lives on the coast. How this would affect the rest of the global community – both nationally and internationally – is difficult to predict, but the consequences will definitely be devastating.

It is no coincidence that the 2007 Nobel Peace Price was awarded to the IPCC for providing important scientific information and to Al Gore for his documentary “An Inconvenient Truth” (2006) that promotes public awareness about global warming and climate change and motivates people to change their destructive behaviors. Indeed, there is still some time to slow down global warming and its harmful effects, but it requires immediate action towards reducing CO<sub>2</sub> emissions globally. To ensure this change, people need to be *ecologically literate*: that is, to understand how this planet works, what is going on right now, and what to do about it.



Beginning in the early 1990s, some advanced thinkers of our time envisioned the ongoing global ecological crisis and called for the need for educational reform to prepare people for the world we are inheriting now (Van Matre, 1990; Meadows et al., 1992; Orr, 1989, 1991, 1992, 1994; Capra, 1999). In the light of the above IPCC report (2007) and the ongoing environmental changes, David Orr's following words sound like a verdict: "Finally, it is time to establish national goals for ecological literacy and make these a vital part of the curriculum of public schools and colleges" (Orr, 1994). It is a requirement of our time that *ecological or sustainability literacy, and environmental or sustainability education* (all four terms are used as synonyms in this work) must become a part of any professional curriculum in higher education because today's college students are tomorrow's decision makers and the key-players at local, national and international levels, who will define further development on this planet.

But what is ecological literacy? The notion of eco-literacy or sustainability education is still vague and indistinct due to its broad, multi- and interdisciplinary nature. On the one hand, as I have realized through my teaching, students are frustrated by information regarding the ongoing and accelerating ecological crisis and often feel hopeless about their and their children's uncertain future; they are not sure and often do not believe that each individual can make a difference and contribute to a positive change. And "our goal as educators," as Orr has remarked, "is to present a sense of hopefulness to students, and the competence to act on that hope" (Janas, 1998). The public is also awakening and often moved, but typically lacks the knowledge and skills to live sustainably.

On the other hand, teachers, instructors, and educators (including parents and faith community leaders) are not only confused by the overwhelming flow of information on sustainability and sustainable living but often are lost trying to adapt multiple and various approaches to ecological/sustainability education. A common methodological and pedagogical approach to teaching sustainability does not exist.

The importance of education for a sustainable future has been recognized by the global community and emphasized by the United Nations since the Earth Summit in Rio de Janeiro (1992) that, with 30,000 people and more than 100 heads of state participating was the largest international environmental conference ever held. Ever since, there has been a consensus that education is the driving force to bring about a shift to sustainable development. This has led eventually to the establishment of the UN Decade of Education for Sustainable Development (DESD) for the period 2005-2014. Yet, although UNESCO states that “while there is overall agreement on principles of sustainability and supporting concepts”, it also points out that “no universal models of ESD exist” (UNESCO, 2005). Thus, even though we are in the sixth year of the United Nations Decade of Education for Sustainable Development (2005-2014), a common conceptual approach to teaching sustainability does not exist.

My recent participation in the annual meeting of the North American Association for Environmental Education (NAAEE) in November 2007, and specifically full-day sessions with the Sustainability Education Commission and the International Commission, has shown that both academics and practitioners are not unified in their ideas about what exactly sustainability is and how to teach it. As Jamie Cloud, the director of the Cloud Institute for Sustainability Education in New York City described

the situation: “We are teaching something we do not know, and teaching it without knowing how to do it” (personal communication, NAAEE 2007).

Thus, the practitioners fully understand the importance of sustainability education and are passionate about promoting it, but they do not know “what” to teach and “how” to teach it. They are lost and need a conceptual model to become effective. There are multiple and variable approaches to sustainability education, but the common approach to the concept of sustainability as well as the methodology and pedagogy of teaching it are missing.

Indeed, the list of existing approaches to sustainability education is impressive: eco-literacy, Earth education, global education, science education, integrated education, education on living systems, humane education, noospheric education, holistic education, spiritual education, experiential education, Nature education, Waldorf education, and Permaculture education – just to mention the most popular. In turn, each of these approaches contains its own list of subjects, tools, and skills that each particular author finds necessary for students to learn in order to become motivated enough to practice a sustainable way of life.

David Orr, the author of the concept of eco-literacy, argues that no student should graduate from any educational institution without basic knowledge of subjects such as “the laws of thermodynamics, the basic principles of ecology, carrying capacity, energetics, least-cost, end-use analysis, limits of technology, appropriate scale, sustainable agriculture and forestry, steady-state economics, and environmental ethics” (Orr 1994). Steve Van Matre (1990, 1995), the creator of the “Earth Education” concept, also emphasizes that to be ecologically literate, everyone should acquire four key

understandings that explain the basic functions of how life works on this planet: “the flow of energy, the cycling of matter, the interrelating of life, and the changing forms.” Elizabeth Sahtouris (2002) suggests that “we replace our environmental education with education on Living Systems” and if she was “the designer of our education system, [she] would make Living Systems the overarching concept for all studies”.

Many authors emphasize the importance of ethics and spirituality for achieving the aims of sustainable development (e.g. Orr, 1992, 1994; Swan, 1995; Meadows et al., 1992, 2004; Carroll, 2004; Edwards, 2005; Lash, 2006; Layzer, 2006; Waters, 2006). Indeed, this dimension of ecological literacy is vitally important because the ecological crisis we are facing now is in fact a crisis of our whole culture. The crisis includes all components of culture such as education (information, knowledge), arts (art, music, literature, and related intellectual activities), morality (system of values, standards of conduct that are accepted as right and wrong), and spirituality (sense of wonder and beauty, awe for creation, reverence for life, and connection with nature). As a matter of fact, this is a crisis of our worldview, our vision of the surrounding reality and attitude toward it at all levels of our life that leads to a decline in culture, a “*cultural decay*” in Paul Brockelman’s interpretation (1997, p.34).

Nevertheless, even knowledge, ethics and spirituality are not sufficient to ensure a much needed change in people’s lifestyles and behaviors moving towards a more sustainable future. People need to have concrete knowledge about, and often practical training with, the tools and skills that would allow them to practice a sustainable way of life. In general, people are not very certain about what sustainability is and they associate it with numerous things, processes, and tools that range from energy-safe bulbs to organic

agriculture, but often they do not see a big interactive picture and their individual place in it.

However, even all of these factors are not sufficient for developing ecological literacy if they are not given in the context of the idea of the wholeness of the existing world: its interconnectedness, interrelatedness, and interdependence. Knowledge of these elements of culture must be transformed into a real, integral picture of the world, which should be kept in mind and pointed out to the students by instructors each time when an appropriate case is presented. In other words, a systematic approach and holistic vision of our reality should be the context of all educational activity. Basics of ecology, global ecology, and Earth system science should be the core disciplines providing the medium for cultivating a new, ecological worldview. And here emerges the incredible importance of Vladimir Vernadsky's theory of the biosphere and the noosphere (1926, 1945), which history has proven to be the scientific foundation for the most progressive – global, ecological, and holistic – worldview.

Paradoxically, Vernadsky's name was not known in the West until the end of the Cold War, but for more than half a century his ideas provided an invisible foundation for many fields and branches of modern science, and have been used widely. These ideas predetermined the appearance and influenced the development of such important disciplines as biogeochemistry, global ecology, and Earth system science. It is essentially Vernadsky's theory of the biosphere and the noosphere that is embodied in the global approach to ecological problems and sustainable development. In light of the impending global ecological crisis, there is an indisputable need to educate people in a new, global

and ecological worldview; it is time to recover and renew Vernadsky's theory of the biosphere and the noosphere in public debate.

Vladimir Ivanovich Vernadsky (1863-1945) was a prominent Russian researcher and scholar, a philosopher, a thinker, an organizer of science, a public figure, and an educator. He was one of the few generalists and polymaths, a unique figure in



*Figure 1.* Vladimir Ivanovich Vernadsky (Synergetic Press, 2007).

the extremely specialized science of the 20<sup>th</sup> century. His research ranged from meteorites and cosmic dust to microbiology and migration of microelements via living organisms in ecosystems, and resulted in publication of 416 works during his lifetime (Pyatibratova, 2000), most of which became classic scientific papers in many fields.

His work served as a foundation for the creation of new branches of science such as radioecology, cosmochemistry and biogeochemistry, and predetermined the appearance of new disciplines like Earth system science, global ecology, environmental philosophy, environmental science and conservation. Vernadsky's ideas underlie the concept of sustainable development formulated under the aegis of the United Nations. Numerous volumes of his writings and materials were published after his death, and this work is ongoing today.

Vladimir Vernadsky elaborated on the concept of the biosphere as a planetary and cosmic phenomenon during the first quarter of the 20<sup>th</sup> century. His concept of the biosphere was expounded in his book *The Biosphere* published in Russian (1926) and French (1929). Western scientists were only able to read an English translation of Vernadsky's *The Biosphere* in 1986 (in an abridged version), i.e. 60 years after its first publication in Russian and 57 years later than in French. The first full English translation of *The Biosphere* saw the light only in 1998 (Vernadsky, 1998).

According to Vladimir Vernadsky, the noosphere is a new evolutionary stage in the development of the biosphere when the human-and-nature interaction will be consciously balanced. "Looking far ahead, Vernadsky considered the emergence of the noosphere as a critical evolutionary step needed for preserving and reconstructing the biosphere in the interest of humanity as a single entity" (Smil, 2002). In our time of the impending global ecological crisis and uncertainty about the future, it is important to include Vernadsky's theory of the biosphere and the noosphere into the sustainability education curriculum because his concept carries an interdisciplinary and systems

thinking approach, ecological and holistic worldview, and an optimistic vision of our future.

*The overall purpose of this study* is to elaborate, based upon the work of Vladimir Vernadsky (1926, 1945, 1998) and others, a conceptual approach to universal sustainability education that could be effectively used by educators at all levels, both in formal (i.e. general education and special courses) and informal settings. *The objectives of the study* could be formulated as the following questions:

- (1) Why has it been said that the ongoing global ecological crisis is a spiritual crisis and that there is a vital need for a new, ecological and holistic worldview?
- (2) What do the “Vernadskian renaissance” and “Vernadsky’s scientific revolution” mean?
- (3) What is Vladimir Vernadsky’s theory of the biosphere and noosphere and how does it inform the ongoing sustainability revolution?
- (4) Why is the UN Decade of Education for Sustainable Development a real challenge for educators?
- (5) Why are values, spirituality, and connection with nature important for achieving the aims of sustainable development?
- (6) Why is the cooperation of science and religion a crucial prerequisite in enabling the switch to a sustainable way of life?
- (7) Why Vernadsky’s biosphere and noosphere theory should be integrated into education?
- (8) How can Vernadsky’s ideas be practically applied to the teaching of sustainability and what are existing examples of this application?



The composition of this dissertation is based on the following assumptions. Knowledge and ecological awareness is the foundation for sustainability education, but it is not sufficient to motivate people for sustainable living. Re-consideration of our value system and ethics, and re-establishing our connection with nature, is a crucial element of sustainability education. To ensure such an important change in people's lifestyles and behaviors in order to move toward a sustainable future, we need not only to educate people about the tools, skills, and strategies for sustainable living. All elements of human nature (mind, heart, body and spirit) are supposed to be engaged in the process of learning to make it effective and sufficient to motivate people to change their behaviors, attitudes, and lifestyles to more sustainable approaches.

However, all of these factors are not sufficient for sustainability education to be effective if they are not given in the context of the idea of the wholeness of the existing world: its interconnectedness, interrelatedness, and interdependence. Knowledge of these elements of culture must be transformed into a real, integral picture of the world, which should be kept in mind and pointed out to students by instructors each time an appropriate case is presented. In other words, a systematic approach and holistic vision of our reality should be the context of all educational activity.

Along with an extensive literature review and critical thinking and analysis, as a major method in my research I use *the Systems Thinking approach*, which enables the finding of effective solutions for complex problems because it considers a system not just as a sum of its parts, but as a group of interacting and interdependent elements forming a complex whole (Goodland, 1995; Anderson & Johnson, 1997; Meadows, 1998; Meadows, Randers & Meadows, 2004). Based upon Vernadsky's original work, an

extensive literature review, and using the Systems Thinking approach and my positive teaching experiences in applying Vernadsky's ideas to teaching of sustainability, the present research shows that Vernadsky's theory of the biosphere and the noosphere represents a viable conceptual framework for universal sustainability education that can be effectively used by educators at all levels and in various settings.

The above research is also directly related to my long-term goal of promoting ecological awareness and a sustainable way of life through teaching interdisciplinary courses at the college level. I believe that promoting and cultivating a new, ecological and holistic worldview and ethics, through developing and teaching new, multidisciplinary courses at the interface of the natural sciences, the social sciences, and the humanities is of crucial importance in our time. I also believe that this will help students to form respectful attitudes and behavior toward other human beings and the global environment, and will shape their decision-making both in their professional and their personal life, which will be crucial in preventing the global ecological catastrophe.

...One might wonder what James Hansen is doing today – more than twenty years after he tried to convince Congress in 1988 to undertake some measures to slow down global warming. On February 20th, 2007, together with other like-minded professionals – Susan Szenasy (*Metropolis* magazine), Edward Mazria (AIA, Founder, Architecture 2030), and Chris Luebke (Director, Global Foresight and Innovation Initiative, ARUP) – he launched “the *interactive* web-cast broadcast live from New York City to over 250,000 students, faculty, administrators, design professionals and government officials in the United States and all over the world” (The 2010 Imperative and Architecture 2030). The event was called *The Global Emergency Teach-in* or *The 2010*

*Imperative* – an educational initiative that reached “hundreds of thousands of students, faculty, deans, and practicing professionals in the architecture, planning and design communities in North and South America and around the world to discover how they inadvertently fuel global warming through design, and what they can do to change this,” says Kristina Kershner (Architecture 2030). The challenge “calls for all new buildings and major renovations to immediately reduce their energy consumption by 50%, and all new buildings to be ‘carbon neutral’ by 2030”. Taking into account that in the US buildings are responsible for almost half (48%) of all greenhouse gas emissions annually, and that globally the percentage is even higher, the above initiative and challenge are extraordinary.

It seems that James Hansen and his collaborators have found a high-leverage transformative factor for system change that lies in education: “To successfully impact global warming and world resource depletion, it is imperative that *ecological literacy* become a central tenet of design education,” James Hansen says (The 2010 Imperative). The truth is that in order to switch to a sustainable mode of living, we need to redesign not only the outer landscape – literally and figuratively – but also our inner landscape. And this essentially is what the present research aims at: to show that Vernadsky’s theoretical system could be used as a ready-to-use conceptual framework for sustainability education to enable teachers at all levels to work effectively towards the needed transformation of the biosphere to the noosphere.

## **CHAPTER I**

### **GLOBAL ECOLOGICAL CRISIS: A CALL FOR A NEW, ECOLOGICAL AND HOLISTIC WORLDVIEW**

We live at a unique moment in the history of humanity. According to Vladimir Vernadsky, in the 20<sup>th</sup> century humanity has become the most powerful geological force that is changing the face of our planet (Vernadsky, 1926, 1944, 1998). However the creative potential of humankind has not always been used to improve the environment and to resolve global social and economic problems but often to damage or destroy both the environment and ourselves. As a result, we are living through a global ecological crisis, hurtling towards a global ecological catastrophe. The crisis encompasses all spheres of human activity and puts at risk even the further existence of our civilization. The scope of this crisis generates fear and hopelessness, negativity, and pessimism. Based on this situation and the fact that the Maya calendar ends in 2012, some claim that we are approaching the end of the world and that the collapse of our culture is inevitable. On the other hand, some call our time a sustainability revolution or the most powerful social transformation movement in the history of humanity (Meadows et al., 2004; Edwards, 2005; Orr, 2005; Hawken, 2008). Others name it a Vernadskian revolution or a revolution in human consciousness (Grionevald, 1998; Waters, 2005). What do all these revolutions mean? Why has it been said that the ongoing global ecological crisis is a spiritual crisis? Does humanity have reasons for optimism and hope for the future? What

is awaiting us: the total collapse of human culture or a just and sustainable future? Why is Vladimir Vernadsky's theory of the biosphere and noosphere, only recently rediscovered by the West, generally acknowledged as a new paradigm and a theoretical foundation for Earth system science and the concept of sustainability (Grinevald, 1998; Margulis et al., 1998; Smil, 2002)? What is an ecological and holistic worldview and why is it important to expand our perspective from anthropocentric to ecocentric? This chapter is an attempt to clarify these questions and, simultaneously, it is a call to educators at all levels, including teachers, religious leaders, and parents, to promote and cultivate an ecological and holistic worldview to ensure the switch to sustainable development and a decent life for generations to come.

### **The Ongoing Ecological Crisis is a Crisis of our Values and a Spiritual Crisis**

In 1897, Anton Chekhov wrote: "Man has been endowed with reason, with the power to create, so that he can add to what he has been given. But up to now he hasn't been a creator, only a destroyer. Forests keep disappearing, rivers dry up, wild life's [sic] become extinct, the climate's ruined and the land grows poorer and uglier every day" (Chekhov, 1897). It is difficult to believe that this concept was a concern more than 100 years ago, at the time of the beginning of capitalism and the industrial revolution, when humans seemed not to have enough technical power yet interfered so destructively with nature. Science and technology has made incredible progress since then and the question of damaging and degrading the environment was scientifically articulated for the public about 50 years ago (Carson, 1962). However, the environmental destruction has not slowed down, the situation has worsened dramatically, and the reality is that we are

hurtling toward a global ecological crisis. Just a simple sampling of the facts of the deteriorating environment, made by David Orr from magazines and newspapers on his desk in 1994, shows how serious the situation has become: “male sperm counts worldwide have fallen by 50% since 1938; human breast milk often contains more toxins than are permissible in milk sold by dairies; at death, human bodies often contain enough toxins and heavy metals to be classified as a hazardous waste; U.S. industry releases some 11.4 billion tons of hazardous wastes to the environment each year; ultraviolet radiation reaching ground in Toronto is now increasing at 5% per year” (Orr, 1994).

The above list could be continued endlessly from a wide range, including scientific journals and books, the mass media, the internet, and newspapers,. The threat of approaching ecological collapse is obvious. Although the present generation may escape the terrible and unpredictable ordeals that become increasingly inevitable as the global ecological crisis builds, the next generation will not be able to avoid the painful consequences of the problems that are developing today. It is not only remote future generations, but our children and their children as well, who will be forced to deal with such increasing global problems as global warming, holes in the ozone layer, exhausted non-renewable natural resources, heavily polluted waters and air, destitute populations, and destroyed soils and forests.

Of all the environmental problems, global warming is the most dangerous and threatening. On June 23, 1988, James Hansen, a NASA scientist, testified before Congress that he was 99% confident that “the greenhouse effect has been detected, and it is changing our climate now” (Statement, 1988). The same year the Intergovernmental Panel on Climate Change (IPCC) was created by the United Nations and 2,000 leading

experts from all over the world started working to understand “the scientific basis of risk of human-induced climate change”. Although during the following years “the IPCC has reported with increasing certainty that man-made emissions of greenhouse gases are causing rapid and potentially damaging changes in the global climate” (IPCC Assessment Report, 1990, 1995, 2001; quoted in Lazer, 2006), there has been an intense scientific and political debate whether this is true.

But now the denial is over. On February 3, 2007, the IPCC released its latest report, which is the result of the six years work by 2,500 scientific expert reviewers, 800 contributing and 450 lead authors from 130 countries. The report provides *unequivocal* scientific evidence of human-induced global warming, and analyzes its causes and possible consequences (IPCC Report Summary, 2007). This means that from now on the debate on this topic must shift from the question “Does global warming and climate change really exist?” to “Is it too late to do something about it?” Indeed, even if we stop all CO<sub>2</sub> emissions immediately, global warming will continue for the next 100 years (IPCC, 2007), resulting in an increased number and intensity of such disastrous events as hurricanes, floods, heat waves, droughts, water and food shortages, and infectious diseases.

Why is this happening? Does humankind not have enough scientific, intellectual, economic, and technical resources to realize that human existence is endangered, and consequently, to slow down the destructive processes threatening its own survival? Indeed, we have sufficient knowledge and the technical potential to change our behavior, which is not only destructive of the natural world but also suicidal. The problem is that “the global environmental crisis, which threatens not only the future of human

civilization but all life on earth, is fundamentally a moral and religious problem” (*Spirit and Nature*, 1992), the crisis in morality and education (Berry, 1991; Orr, 1994; Kelly, 2004). Paul Brockelman goes further, connecting the ecological crisis with the culture of our society, which in his words is a “*culture of spiritual collapse*,” “*a demoralized culture*” (Brockelman, 1997). “The word *culture* comes from the Latin root *colere*, (to inhabit, to cultivate, or to honor). In general it refers to human activity”; in Andre Malraux’s definition, “culture is the sum of all the forms of art, of love and of thought, which, in the course of centuries, have enabled man to be less enslaved” (Wikipedia Encyclopedia,<sup>1</sup> 2004).

Indeed, the ecological crisis we are facing now is a crisis of our whole culture. The crisis includes all components of culture such as education (information, knowledge), arts (art, music, literature, and related intellectual activities), ethics/morality (system of values, standards of conduct that are accepted as right and wrong), and spirituality (sense of wonder and beauty, awe for creation, reverence for life, and connection with Nature). This is a crisis of our worldview, our vision of the surrounding environment, and attitudes towards it at all levels that leads to a decline in culture, a “*cultural decay*” in Brockelman’s interpretation (Brockelman, 1997). Intensive discussion of these issues continues in academic, educational, and religious circles.

As values are at the core of all human decision-making and underlie all of our actions, it is no surprise that the global crisis has spread recently to the financial and economic spheres. Experts have recognized that institutional greed and avarice were responsible for the collapse of the U.S. financial system in September, 2008 (The Market

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<sup>1</sup> All Wikipedia Encyclopedia references in this work were checked against and verified by the Oxford English Dictionary (2010).



Oracle, 2008). Due to globalization and an “increasingly integrated world economy” (Brown, 2008), this had an almost immediate cascading effect on the world financial system. The following development of events has been shocking (CNNpolitics.com, 2008). While the growing financial and economic crisis was hitting ordinary Americans harshly, and the unemployment rate is skyrocketing, U.S. financial companies were using the bailout funds intended to keep them afloat, and ultimately help the American people, to continue with their trips, parties, and bonuses, spending millions of taxpayer dollars on corporate jets, renovations, entertainment, etc. (BBC.News.com, 2009). Indeed, human values do not change overnight.

### **Consumerism and Happiness: False and True Values**

Many authors argue that the main driving force behind the impending global ecological crisis is the idea of “economism” and “growthism” (Brockelman, 1997; McDaniel, 1997; Weiskel, 1997), which in turn, promote and cultivate consumerism. These developments are in progress, but at the expense of a rapidly deteriorating environment and currently emerging global problems for future generations that will have to pay the price for the present generation’s race for the “good life”. But what really is a “good life” in the opinion of people living in today’s economically developed countries? The basic wish for a good life is reasonable and understandable: “We seek to avoid injury and pain and to achieve well-being and happiness. As Socrates put it, people do not just want life, but the good life” (Rockefeller, 1997, p. 48). How does the historical and practical realization of the ideal of “good life” in fact appear in the United States – the most economically developed and most prosperous nation in the world? As Weiskel

comments, “in our culture a desire to pursue “the good life” aggravates our momentous ecological crisis. Consumption patterns of the “Northern” countries and the Western countries are obscene by global standards, yet there is no apparent end in sight to the gluttony. Indeed, as citizens of the United States, we have the right to “the pursuit of happiness” written into our constitution, and in culture the prevailing message is that happiness itself is inextricably linked to an ever greater consumption of material goods (Weiskel, 1997).

How does consumption relate in this country to levels of happiness, which is one of the most important indicators of well-being in a society? Mental models of happiness in this society are based on the rate of consumption and possession of material things, i.e. the more you have, the wealthier, that is the happier you are supposed to be. However, statistics show the situation differently. Americans, living in the wealthiest country in the world, suffer badly from fatigue, stress, and depression. Subjectively, many people do not feel really happy, although they have more than enough. Paradoxically, the human feeling of happiness does not grow significantly with the increase of their possessions. Indeed, “people in the West have got no happier in the last 50 years. They have become much richer, they work much less, they have longer holidays, they travel more, they live longer, and they are healthier. But they are not happier. This shocking fact should be the starting point for much of our social science”, the economist Richard Layard argues (Robbins, 2003). He believes that "happiness depends on a lot more than your purchasing power: “Comparing countries confirms what history also shows – that, above \$15,000 per head, higher average income is no guarantee of greater happiness” (Robbins, 2003).

The United States constitutes about 5% of the world population but consumes 25% of the world's fossil fuels and 24% of produced energy and, furthermore, discharges 72% of hazardous wastes (Perkins, 2007, p. 5). This disproportional behavioral pattern of the US can be explained by the nation's drive to excessive consumerism.

Indeed, there are 700 millions cars in the world, and 200 million of them belong to the Americans (The End of Suburbia, 2004). At the same time, only 8% of the world population owns a car, hundreds of millions of people live in inadequate houses or have no shelter at all, much less refrigerators or television sets; 850 million people chronically eat less food than their bodies require (Meadows et al., 2004).

The most difficult test in life is not the test of poverty, but the test of prosperity, as we say in Russia. How many people are able to withstand the trial of a life of plenty? The numbers are really horrifying. For example, 300,000 Americans die every year of obesity (Affluenza, 2000) that is, as a result of addiction to overeating, the sin of gluttony as interpreted by traditional religions. The statistics relating to other addictions to substances and alcohol, and behaviors such as physical and moral abuse, or "recreational shopping" (Kaza, 1997) is overwhelming. Millions of people on Earth are suffering and dying of starvation at any given moment; in Niger 15 children die of starvation every day and of every 1000 children born there, 262 fail to reach their fifth birthday (Wanniski, 2005).

As a matter of fact, consumerism is at the core of the whole American life style, which is determined by our values. There are many elements in this system, but mass media seems to play a decisive role in creating and promoting certain societal values. For me, as a person who grew up in Europe, it was very surprising to watch American TV

about 10 years ago, when I visited the US for the first time. I first found US television very disturbing due to interruptions every few minutes for commercials, half of which would promote “tasty, fantastic, enjoyable food”, and the other half, weight loss programs. All this was combined with the transmission of very limited information about the rest of the world. When I returned to the US three years later, something had changed. There were fewer food ads, but people were still bombarded with a colossal number of commercials that preach comfort and a luxurious way of life, material possessions and consumption, consumption, consumption...

However, not many people in prosperous countries are aware of the fact that “on average, a person in a ‘high-energy’ country consumes eighteen times more commercial energy than a person in a ‘low-energy’ country. As a result, people in ‘high-energy’ countries cause much more environmental destruction than people in ‘low-energy’ countries” (Prescott-Allen, 1992).

As shown above, the culture of consumerism has infected the minds and souls of many people, driving their behavior in a destructive manner toward themselves, other creatures, and the planet as a whole. Therefore, it has been said that the environmental crisis is truly a “spiritual crisis”; it is the *spiritual* and *cultural decay* in Paul Brockelman’s definition, or a *demoralized culture* in Vaclav Havel’s words (quoted in Brockelman, 1997), when “ethical ideals are simply reduced to the dreams of the consumer society or the lonely individuals who inhabit it” and “we have become spiritually, morally, and ecologically disoriented” ” (Brockelman, 1997).

Thus, excessive, wasteful, and meaningless consumerism manifests the collapse of spirituality and the failure of faith in terms of traditional values in contemporary

society. It did not happen overnight; true spiritual and moral values were gradually turned into sins, and vice versa, sins became “engines” of success in modern economically developed societies. It is striking that three very different prominent thinkers of our time – Wendell Berry (1995), David Orr (1994), and Daniel Kemmis (1990) – independently and spontaneously relate the roots of consumerism to the process of deformation of moral values that has been progressively occurring since the time of the frontier. Behaviors traditionally regarded as sins by all major religions have, in fact, been transformed imperceptibly into “virtues” over the past two centuries. This transformation has happened with the help of industrialization, as the economy of greed was effectively practiced and the vast resources and space of this country provoked people to “believe that the lands, forests, mineral wealth, waters, and air of America can be made to fuel endless economic growth” (Orr, 1994).

Jay McDaniel (1997) also argues that “devotion to the god of endless growth seems to have emerged some three centuries ago with the dawn of the industrial revolution in the West”. His diagnosis is rather severe and, in fact, sounds more like a drastic sentence for the modern society: “A religion is a way of organizing life. In our time the dominant religion of the planet is ‘economism’. Its god is endless economic growth, its priests are economists, its missionaries are advertisers, and its church is the mall. In this religion, virtue is called ‘competition’ and sin is called ‘inefficiency’. Salvation comes through shopping alone” (McDaniel, 1997).

Indeed, at the expense of true values, consumerism is promoted in the modern society and often becomes the main purpose of life for the majority of people in developed countries. However, more and more people are realizing that money can’t buy

love, health, compassion, and friendship. People are starting to realize that in their endless rush for consumption they lose real values and the simple joys of life that could never be bought with money. Sadly, instead of these traditional values, false “values” like greed and avarice are cultivated in this society in the form of consumption, materialism, and individualism; and as a result, people are easily manipulated by business and the power that comes with it, and humanity’s ecological impact on Earth is progressively increasing (Merkel, 2003; Meadows et al., 2004).

### **Anthropocentric vs. Ecocentric Worldview:**

#### **Does Nature Have an Intrinsic Value?**

The world is in “overshoot mode” now, which means that human demand for natural support systems exceeds what they can provide. The ecological footprint of humanity, i.e. the land area that is required to provide the resources for global society and to absorb its emissions, exceeds natural supplies from the early 1980s (Ede, 2002; Merkel, 2003; Wackernagel & Rees, 1996). According to the Global Footprint Network, in 2008 humanity used about 40% more than nature can regenerate and absorb in the course of one year (Global Footprint Network, 2008). This means that we “currently consume 1.4 planets’ worth of global resources each year... eating into the natural capital, undermining its ability to produce for the future. We’re consuming on credit and accumulating ecological debt that we have no way to repay” (Leonard, 2008).

It is clear that if we continue this way, global ecological catastrophe is inevitable. However, many people think that the situation could be easily resolved by advances in technology. Donella Meadows with coauthors respond to these expectations in the

following way: “Both the market and technology reflect the values of those who create them. When people disregard nature, ignore social inequality, and believe that force is the way to resolve conflict, then they will create markets and technology that destroy nature, widen the gap between the rich and the poor, and promote warfare” (Meadows et al., 2004). Furthermore, a new technology often creates new problems; for example, the case of the energy-saving light bulbs that turned out to contain mercury and cannot be thrown away. I wonder how many people know about this and whether they will follow the instructions for proper disposal?

The notion that “unlimited” resources such as air and water, coupled with new technological inventions, will serve as an inexhaustible resource could also be false. With the growth of consumption increasing worldwide, these “unlimited” resources can easily move to the category of “limited” resources simply because there would not be sufficient time for their natural cycling. Thus, to solve global problems we cannot entirely rely on technology but instead have to reduce our “appetites” and to re-consider our value system.

Indeed, behind the impending global ecological crisis there are destructive human behaviors that are driven by our value system and worldview. In the context of the impending ecological crisis, the question of whether value resides in the object (nature) or the subject (people) is definitive with respect to the approach to environmental issues. There are two main positions in relation to nature: *anthropocentric* and *ecocentric*.

Our culture embodies an *anthropocentric* approach. Judeo-Christian culture was based on the notion that man is “the pinnacle of the creation” (Genesis 1.26-1.28). This idea was later indirectly “supported” scientifically by Darwinian theory of evolution

(Darwin, 1971). This traditional, human-centered philosophical view that everything in the environment exists as an instrument for man, who acts as a controlling authority over nature, is called *anthropocentrism*. Man is considered the most important entity in the universe and treated as preeminent, while other creatures are regarded as subordinate under the domination of humans.

Environmental anthropocentrism is the view that all environmental responsibility comes exclusively from human interests. A typical example is provided by an engineer who received his B.S in electrical engineering from Tufts University and M.S. from Dartmouth College: “It is not shortsighted to say that we need only be concerned with the desires of living human beings; living human beings are the sole source of all value in the known universe. If existing humans wish to burn fuel, cut trees, and kill animals, then that is exactly what they should do” (Halbrooks, 2002).

The above is an extreme example of the *anthropocentric* perspective, and expresses total blindness to the fact that everything in the world is interrelated, interconnected, and interdependent. An *ecocentric* perspective recognizes the intrinsic value of nature and considers that “the well-being and flourishing of the living Earth and its many organic/inorganic parts have value in themselves (synonyms: intrinsic value, inherent value). These values are independent of the usefulness of the nonhuman world for human purposes” (Rowe, 1996).

By definition, ecology is the study of the relationships between organisms and their environment: “The word ecology is derived from the Greek *oikos*, meaning ‘household,’ combined with the root *logy*, meaning ‘the study of’” (Odum, 1989). Environment, according to the science of ecology, includes both biotic factors (other



organisms, and their functioning and by-products) and abiotic or physical factors (such as temperature, light, habitat, etc.). Hence “ecological” means all possible aspects of the interaction of organisms with their environment and amongst themselves. From an ecological point of view, humans are the dominant organisms on the planet – not quantitatively but qualitatively – due to their power to impact the global ecosystem. That is why the global ecological crisis encompasses all possible dimensions of the global environment (including its biotic and abiotic components) and human society as a whole. The developing global financial and economic crisis that started in the fall of 2008 is the logical continuation of the developing global ecological crisis.

From an ecological point of view there cannot be insignificant or unimportant components in natural systems, i.e. all elements of a system matter. An outstanding Russian scientist Vladimir Vernadsky, “a principal architect of our contemporary ecological vision of the biosphere” (Engel, 1990), has summarized this aptly with the phrase “There is nothing large or small in nature” (Vernadsky, 1930, quoted in Grinevald, 1998, p. 21).

An ecological or ecocentric worldview is a holistic view of the world. Holistic theory holds that “the whole is greater than the sum of its parts” and that the “parts of any whole cannot exist and cannot be understood except in their relation to the whole” (The Free Dictionary, 2009).

The essence of the ecological perspective is that it is based on a systems thinking approach, which considers all elements of any system in their interconnectedness, interdependence, and interaction (Meadows et al., 2004). Only this approach enables to see, to understand, and to resolve the complex problems of our time in their totality.

Further, from the ecological (i.e. scientific) point of view, all people belong to the same species and represent one global community within the largest known ecosystem – the biosphere.

An ecocentric worldview is also directly related to our *spirituality*, which manifests itself through people's highest values, feelings, and aspirations: awe for creation, love for nature, a sense of beauty, oneness with life and the universe, gratitude and a desire for the common good. In our technological age, many people lack these values. It was always the job of world religions to maintain and cultivate traditional values in their societies. They were and continue to be the only domains where our values are openly discussed, questioned, and often formed. However, in light of the developing ecological crisis, it is not sufficient to promote humanity's traditional values, because the impending ecological crisis is in fact a spiritual crisis, i.e. the result of the lack of spiritual values in contemporary human society.

Faith communities, along with schools and parents, are called to play an extremely important role in cultivating spiritual values. As a matter of fact, many congregations are already involved in this process. For example, in the fall of 2006, thousands of faith communities and Christian denominations throughout the United States showed Al Gore's movie "An Inconvenient Truth" (2006). This allowed hundreds of people to become aware of global warming, our role in it, and what we can do about it. This was also an event of great spiritual value, as many people realized that they are part of the Earth's ecological system and that we all are in the "same boat." This example alone shows how powerful and effective the faith communities can be in promoting ecological awareness and a sustainable way of life, because the people involved are already open to

a value-laden message. Faith community leaders are doing an irreplaceable and invaluable job for all of humanity and the common good by helping their congregations to become aware of what is going on both on a local and a planetary level and by making connections between *traditional values* (which are embodied in all kinds of religions and are in fact universal) and the highest, *spiritual values*.

Although many educational institutions are involved in promoting environmental awareness and sustainability, the spiritual and moral component of an ecocentric approach is often missing. It is still considered “inappropriate” (i.e. anti-intellectual) to discuss moral and spiritual values in an academic setting. Indeed, as soon as educators decide to teach morality, they face serious difficulties posed by questions like, “Whose values are [you] going to teach? Are you going to teach religion?” (Kelly, 1999). And here is an exceptional role of religion and religious leaders in our time. They can provide people with the needed ecological perspective that includes not only scientific knowledge about how our planet works, but also traditional and spiritual values that are essentially at the core of an ecocentric worldview.

### **Vladimir Vernadsky’s Theory of the Biosphere and Noosphere:**

#### **A Scientific Foundation for an Ecological and Holistic Worldview**

An ecological and holistic perspective is embodied in Vernadsky’s theory of the Biosphere and the Noosphere: “...no living organism exists on earth in a state of freedom. All organisms are connected indissolubly and uninterruptedly, first of all through nutrition and respiration, with a circumambient material and energetic medium. Outside they cannot exist in a natural condition,” he wrote in 1944 (Vernadsky, 1944,

1945). Although Vernadsky did not use the term “ecology”, the focus of his seminal work was on the largest ecological system we know – the biosphere. What we understand as global ecology now, Vernadsky defined as *the science of the biosphere* (originally intended to be the “economy of nature”) whose founder he has historically turned out to be.

Today, the word *biosphere* is a common word in our language; it is widely used by mass media and by ordinary people. However, how many people associate this word with Vladimir Vernadsky? What does the term biosphere really mean? What is the noosphere in Vernadsky’s interpretation?

Vladimir Ivanovich Vernadsky (1863-1945) was a prominent Russian researcher and scholar, a philosopher, a thinker, an organizer of science, a public figure, and an educator. He was one of the last polymaths<sup>2</sup> and generalists<sup>3</sup> – a unique figure in the extremely specialized science of the 20<sup>th</sup> century. His research ranged from meteorites and cosmic dust to microbiology and migration of microelements via living organisms in ecosystems, and resulted in publication of 416 works during his lifetime, most of which became classic scientific papers in many fields (Pyatibratova, 2000). Numerous volumes of his writings and materials were published after his death, and this work is still going on today.

Paradoxically, Vernadsky’s name was not known in the West until the end of the Cold War, but for more than half a century his ideas provided an invisible foundation for

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<sup>2</sup> Polymath – similar to a Renaissance Man, a “universal” man, i.e. a person “whose knowledge is not restricted to one subject area” and who “excels in a wide variety of fields” (Wikipedia Encyclopedia, 2009), a person of encyclopedic knowledge.

<sup>3</sup> Generalist – a person whose knowledge, aptitudes, and skills are applied to a variety of different fields (opposite to a specialist) (Dictionary.com, 2010).

many fields and branches of modern science, and have been widely used. These ideas predetermined the appearance and influenced the development of such important disciplines as biogeochemistry, global ecology, and Earth system science. It is essentially Vernadsky's theory of the biosphere that is embodied in the global approach to ecological problems today. Vernadsky's ideas underlie the concept of sustainable development formulated under the aegis of the United Nations (UNESCO, 1987). His concepts are also at the core of a newly emerging discipline – sustainability science – that seeks to understand the human-environment systems interaction (Clark, 2007).

Only at the end of the century was the value of Vernadsky's ideas fully understood and after years of silence, the West finally started to discover and scientifically recognize his creative genius as elaborated in the concept of the biosphere. Vernadsky's work on the concept of the biosphere has been acknowledged by a range of prominent contemporary scientists and researchers in recent years: “the originator of the modern theory of the Biosphere” (Grinevald, 1998), “one of the greatest thinkers of history and philosophy of science” (Levit, 2001), “what Charles Darwin did for all life through time, Vernadsky did for all life through space” (Margulis et al., 1998), “his name is as inseparably linked with the biosphere as Albert Einstein's name with relativity” (Kauffmann, 1991). In the light of the impending global ecological crisis, there is an indisputable need to educate people in a new, ecological and holistic worldview; it is time to recover and renew Vernadsky's theory of the biosphere and the noosphere in public debate.

Vladimir Vernadsky elaborated on the concept of the biosphere as a planetary and cosmic phenomenon during the first quarter of the 20<sup>th</sup> century. His concept of the

biosphere was expounded in his book *The Biosphere* published in Russian (1926) and in French (1929). Western scientists received the opportunity to read an abridged version of Vernadsky's *The Biosphere* in an English translation only in 1986. The first full English translation of *The Biosphere* saw the light only in 1998 (Vernadsky, 1998), i.e. 72 years after its first publication in Russian.

In Vernadsky's own words, the *biosphere* is a "definite geological envelope markedly distinguished from all other geological envelopes of our planet. This is only because it is inhabited by living matter, which reveals itself as a geological force of immense proportions, completely remaking the biosphere and changing its physical, chemical, and mechanical properties" (Vernadsky, 1944). According to Vernadsky, the biosphere includes the totality of living organisms on the Earth with their environment – i.e. those parts of the atmosphere (Earth's air envelope), the hydrosphere (Earth's water envelope), and the lithosphere (the outer solid shell of the Earth) in which life exists. In his definition, the biosphere is a single greatest geological force on the Earth, moving, processing, and recycling several billion tons of mass a year.

Vernadsky developed a complete theory about the Earth's biosphere of planet Earth in two monographs and several dozen papers. He specified the boundaries of the biosphere, explicitly defined the difference between living and non-living matter, determined the total mass of living matter, calculated the amount of cosmic energy that is absorbed by the biosphere through trapping of solar energy by chlorophyll of green algae, and determined cycles of chemical elements passing through the living organisms of the biosphere, along with many other aspects and features of Earth's functional systems as a living planet.

It is remarkable that Vernadsky saw the biosphere as a planetary and cosmic event: “In the biosphere thesis, the Earth represents itself as a small particle in a gigantic Universe, a minute oasis where under some laws the conditions for life emerged, life which the Earth protects from penetration by Sun’s ultra-violet rays” (Arbatov & Bolshakov, 1987). It was a new way of looking at the Earth – as if he observed the Earth from space, although exploration of space started significantly later. In his vision of the Earth as a complex system and a sub-system of a greater – cosmic reality – Vernadsky was far ahead of his time. Cosmism of Vernadsky is reflected best of all in his own words: “To understand something scientifically means to place an event in the framework of scientific reality – that is Cosmos” (Vernadsky, 1991). Vernadsky’s theory of the biosphere and the noosphere reflects his view of the world that was not only ecocentric (i.e. ecological and holistic) but also cosmocentric.

*Noosphere* translates from Greek as the “sphere of intelligence”. Noosphere literally means the envelope of mind, intelligence or the sphere of human thought. “In our century the biosphere has acquired an entirely new meaning; it is being revealed as a planetary phenomenon of cosmic character... Mankind became a single totality in life on earth... The noosphere is the last of many stages in the evolution of the biosphere in geological history,” Vernadsky wrote in 1945 (Vernadsky, 1945). Pointing out that “through technology and sheer numbers, people have become a geological force, shaping the planet’s future just as rivers and earthquakes shaped its past” (Vernadsky, 1926), he emphasized the responsibility of humans as unique entities in the biosphere because they possess intellect, knowledge and power: “The whole of mankind put together represents an insignificant mass of the planet’s matter. Its strength is derived not from its matter, but

from its brain. If man understands this, and does not use his brain and his work for self-destruction, an immense future is open before him in the geological history of the biosphere” (Vernadsky, 1944).

Vernadsky believed in human reason and its capacity to govern the world wisely. He made a number of predictions about the noosphere, some of which are already being realized: abrupt transformation of means of communication and exchange among countries; an intensification of relations, including political relations, among all countries of the Earth; the predominance of the geologic role of men over other geologic processes that go on in the biosphere; the expansion of the biosphere and man’s emergence into the cosmos; the exploitation of new powerful sources of energy; the equality of people of all races and religions, etc. (Yanshina, 2000). “Looking far ahead, Vernadsky considered the emergence of the noosphere as a critical evolutionary step needed for preserving and reconstructing the biosphere in the interest of humanity as a single entity” (Smil, 2002). According to Vernadsky, the noosphere is a new evolutionary stage in the development of the biosphere when human-and-nature interaction will be consciously balanced: “Eventually, global society, guided by science, may soften the environmental impact, and earth will become a ‘noosphere,’ a planet of mind” (Vernadsky, 1926).

### **From Biosphere to Noosphere: A Revolution in Human Consciousness**

We live at a very special time in the history of humanity – the time of a developing global ecological crisis, when our survival as the human race is threatened by the progressing global warming and climate change. The degree of the emergency we are now facing is the same as in the case of war, and we “will either mobilize together to



save our global civilization, or we will all be potential victims of disintegration” (Brown, 2008).

At the same time, some say that it is a great moment to be alive as we are living through several revolutions – *a sustainability revolution* (Edwards, 2005; Meadows et al., 2004; Orr, 2005), *an information revolution* (Waters, 2006), *a Vernadskian revolution* (Grinevald, 1998; Subetto, 2003), and *the revolution in human consciousness* (Tolle, 2005; Waters, 2006). What are all of these revolutions about?

In the words of David Orr, the “sustainability revolution is nothing less than a rethinking and remaking of our role in the natural world. It is a recalibration of human intentions to coincide with the way the biophysical world works”, a “revolution of charity, magnanimity and spirit”, a “revolution of hope, competence and intelligence underlain by wisdom” (Orr, 2005). Owen Waters calls our time the “revolution in human consciousness”, the “spiritual renaissance”, the “Shift into a New Reality” (Waters, 2005).

The word “revolution” means a radical change, and the above invisible and peaceful revolutions manifest a radical change that is taking place in our inner landscape – in our minds and hearts. This is a radical change in our worldview from anthropocentric to ecological and holistic, and it is a radical shift of our perception of reality – a paradigm shift. This collective “transformation of human consciousness” (Tolle, 2005) manifests itself externally as a “growing awareness of environmental urgency and the gathering social movement for a sustainable future” (Shaping a Sustainable Future, 2008), which Paul Hawken calls the largest social movement in history and defines as a planetary immune system (Hawken, 2008).

Skeptics will be disappointed to learn the unveiled secret about the Mayan calendar that ends on December 21, 2012. As Waters argues, this date is a critical point of a major galactic synchronization and “marks the end of a 26,000 year cycle of a style of human experience, as well as the end of a 5,000 year cycle within that, and also the end of many more sub-cycles, all in synchronicity with each other... On December 21, 2012, when the Mayan calendar resets to zero, a new 26,000 year cycle begins” (Waters, 2006). Indeed, is it not a greatness to be alive at this unique moment in the evolution of humanity?

Although named differently, all of the above revolutions manifest the great change that is happening right now on a global scale – a change in our view of the world from an anthropocentric to an ecocentric perspective. We are entering the age of the noosphere – the next stage in the evolution of the biosphere, when, according to Vernadsky, the interaction between society and nature will be consciously balanced. It is critical, during this time of the impending global ecological crisis and uncertainty about the future, to popularize Vernadsky’s theory of the biosphere and the noosphere and incorporate his ideas into sustainability education. Vernadsky’s work represents a sound example of an interdisciplinary and systems thinking approach, ecological and holistic perspective, and an optimistic vision of the future – the prerequisites absolutely needed to face and properly respond to the challenges of our time in order to successfully switch our path to a sustainable development. This is a requirement of our time to change the way we see the world and ourselves, think and feel, and most importantly, to become active and conscious participants in the new evolutionary stage so ingeniously foreseen by Vladimir Vernadsky.

## CHAPTER II

### THE RENAISSANCE OF VLADIMIR IVANOVICH VERNADSKY AND HIS THEORETICAL SYSTEM

*Now I somehow feel clearly that what I am doing with my geochemistry and living matter is valuable and big. And I am ready to state it bluntly: I am sure that if our time fails to appreciate it, posterity will not... I began to perceive clearly that I was fated to tell mankind something new about the teaching of living matter that I have developed, and that is my destiny... Now I see that this teaching may have the same effect as Darwin's book...*

Vladimir Vernadsky, 1919

*Much time will have to pass before the historian of science will be able to review the vast scientific legacy of Vernadsky and fully grasp the depth and many-sidedness of his influence.*

Alexander Vinogradov, 1963

*Vernadsky was one of the first scientists to emphasize the basic unity of Earth, humans, and the cosmos through the exchange of matter. To Vernadsky, human beings were first and foremost inhabitants of the planet, one component in a cycle of physical and chemical interactions and transmutations, and as such they possessed an obligation to think and to act for the good of the planet as well as for their own personal comfort and well being.*

Kendall E. Bailes, 1990

*Now the time is ripe for the revival of the real historical figure of Vernadsky and his complete work on the Biosphere.*

Jacques Grinevald, 1998

*The breadth of Vernadsky's knowledge of the literature of geology, geochemistry, the biosphere, the kinds of living organisms, and many other topics is simply mind boggling. I began to wonder: **Could anyone alive today duplicate Vernadsky's feat, but this time incorporating all the information that has been added to and expanded upon what was known in his time?***

Frank B. Salisbury, 2007

## **Vernadsky's Scientific Revolution**

After years of silence, the West finally started to discover and recognize Vladimir Ivanovich Vernadsky – a prominent Russian scientist, a philosopher, a thinker, an educator, an organizer of science, a public figure, and a person of encyclopedic knowledge. His genius has been compared to the greatest minds in the history of humanity – such as Galileo, Darwin, and Einstein – who not only advanced the frontiers of knowledge, but also initiated paradigm shift and significantly affected the prevailing worldview of their time. Here are just some excerpts of the leading contemporary western scientists and researchers, philosophers and historians of science, who were astonished by their encounters with Vernadsky's innovative scientific and philosophical thought that in so many ways, though often silently and invisibly, shaped our modern scientific paradigm and view of the world:

- “It is essentially Vernadsky's concept of biosphere... that we accept today” (Hutchinson, 1970);
- “A pioneer in the earth sciences and areas of concern to ecologists” (Bailes, 1990);
- “The originator of the modern theory of the Biosphere” (Grinevald, 1998);
- “A principal architect of our contemporary ecological vision of the biosphere” (Engel, 1990);
- “His name is as inseparably linked with the biosphere as Albert Einstein's name is with relativity” (Kauffmann, 1991);
- “The Vernadskian renaissance... The international revival of Vernadsky... Vernadsky's scientific revolution” (Grinevald, 1998);
- “What Charles Darwin did for all life through time, Vernadsky did for all life through space” (Margulis et al., 1998);
- “One of the greatest thinkers of history and philosophy of science” (Levit, 2001);

- The scientist who elaborated the concept of the biosphere and who is now generally acknowledged as the originator of a new paradigm of life studies” (Smil, 2002);
- A truly global systems thinker who was a hundred years ahead of his time (Volk, 2007)
- Great biogeochemist, founder of biospherics, a genuine hero of thought and action (Allen, 2009);
- It is Vernadsky's work that redefined ecology as the science of the biosphere and placed the biosphere concept in its current central position in earth systems science (Ellis & Bledzki, 2009).

Paradoxically, Vernadsky's name was largely unknown in the West until the late 1980s but for more than half a century his ideas provided an invisible foundation for many fields and branches of modern science, and have been used widely. “Like the periodic table of elements, which, in the United States, is still seldom credited to its Russian inventor, Dimitri Mendeleev, Vernadsky's ideas became widely known even though they were not attributed to their author” (Margulis et al., 1998). This is exactly why a well-known historian and philosopher of science Jacques Grinevald, who is a key expert on the history of the concept of the biosphere, termed the process of penetration of Vernadsky's ideas into modern science as the “invisible Vernadskian revolution” or “Vernadsky's scientific revolution” (Grinevald, 1998).

Indeed, Vernadsky's ideas predetermined the appearance and influenced the development of such important disciplines as biogeochemistry, global ecology, environmental science, Earth system science, and the emerging, sustainability science. It is essentially Vernadsky's theory of the biosphere and the noosphere that is embodied in the global approach to ecological problems and sustainable development. And the further

we move in time, the more people realize Vernadsky's stature. One of Vernadsky's many students and closest collaborators, Alexander Vinogradov, wisely noticed, "Much time will have to pass before the historian of science will be able to review the vast scientific legacy of Vernadsky and fully grasp the depth and many-sidedness of his influence" (Vinogradov, 1963). Indeed, although the recognition and popularity of Vernadsky's theoretical system is definitely growing, there remains a long way to go, before his full impact becomes apparent.

### **The West's Discovery of Vernadsky**

The first spokesperson of Vernadsky's work in the West (Grinevald, 1996; Lapo, 2001) was the founder of the Yale scientific school of ecology George Evelyn Hutchinson (1903-1991) who is widely recognized as a father of limnology<sup>4</sup> and as one of the founding fathers of the science of ecology. Hutchinson learned about Vladimir Vernadsky from his friends and colleagues at Yale University, Alexander Petrunkevitch (a former student and collaborator of V. Vernadsky) and George Vernadsky (a professor of Russian history and the son of V. Vernadsky).

Hutchinson helped Petrunkevitch and George Vernadsky to prepare and publish two of Vernadsky's papers that contained some of the important themes of his work. The first article entitled "Problems in Biochemistry, II: The Fundamental Matter-energy Difference between the Living and the Inert Natural Bodies of the Biosphere" was published in *Translations of the Connecticut Academy of Arts and Sciences* in 1944

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<sup>4</sup> Limnology is the scientific study of bodies of fresh water for their biological and physical and geological properties. The study of freshwater ecosystems (<http://www.biology-online.org/dictionary/Limnology>, Retrieved on February 14, 2010).

(Vernadsky, 1944). The second article, “The Biosphere and the Noosphere,” was published in the January issue of *American Scientist* (Vernadsky, 1945), just after Vernadsky’s death on January 6, 1945. These two papers were the very first English-language publications of Vernadsky’s work and “remained for many years the only pieces of his writing readily available to English-speaking readers” (Margulis et al., 1998, p. 16).

Hutchinson (1970) emphasized Vernadsky’s importance as “the founder of modern biogeochemistry” and reflected on his contribution to modern science in the paper “The Biosphere” published in *Scientific American*:

The idea of the biosphere was introduced into science rather casually almost a century ago by the Austrian geologist Eduard Suess, who first used the term in the discussion of the various envelopes of the earth in the last and most general chapter of a short book on genesis of Alps published in 1875. The concept played little part in scientific thought, however, until the publication, first in Russian in 1926 and later in French in 1929 (under the title *La Biosphère*), of two lectures by the Russian mineralogist Vladimir Ivanovich Vernadsky. It is essentially Vernadsky’s concept of the biosphere... that we accept today.

It is remarkable that both the first and the last paragraphs of Hutchinson’s “The Biosphere” paper are devoted to Vernadsky and his scientific legacy.

Margulis et al. (1998) point out that Hutchinson’s own chapter on the biochemistry of the terrestrial atmosphere (Hutchinson, 1954) in the edited collection *The Earth as a Planet*, “itself embodied a Vernadsky-style conceptual shift” (p. 16).

Hutchinson (1979) shared that he was strongly influenced by Vernadsky’s ideas, which helped him to shape his own scholarly work. In his book *The Kindly Fruits of the Earth: Recollections of an Embryo Ecologist*, he characterized Vernadsky as “the great geochemist” and wrote:

Learning about V.I. Vernadsky from Petrunkevitch and George Vernadsky, I became much interested in some of his ideas... Vernadsky had a strong influence on [some] aspects of my research, and I did my best to help Petrunkevitch and George Vernadsky make his ideas about the biosphere better known in English-speaking countries... I came to biogeochemistry through Vernadsky...

It took more than 40 years, however, after the publication of Vernadsky's two first articles in English (Vernadsky, 1944, 1945) before his most famous book, *The Biosphere* (1926), was translated into English and published in an abridged version in 1986 (Vernadsky, 1986). By then, Vernadsky's ideas had already penetrated the scientific and philosophical thought of European intellectuals thanks to publication of his major writings in French and German, and his visiting Europe for research and lecturing in the 1920s-1930s.

Vernadsky had generously shared his innovative ideas on the biosphere and on the emerging science of biogeochemistry with colleagues, scholars, and students by lecturing and conducting research during his numerous visits to Western Europe between 1922 and 1936. By this time Vernadsky had already formed his theoretical system and articulated it in publications in Russian (1911, 1923, 1926, 1926a, 1928, 1931, 1932, 1933, 1933a, 1934, 1936, 1939, 1940), in French (1924, 1929, 1934, 1935), and to a lesser extent in German (1928, 1930, 1932), in Japanese (1933), and in English (1923).

In the winter of 1922-1923 and in 1924 Vernadsky taught a lecture course on geochemistry at the invitation of the Rector of the Sorbonne (the University of Paris) (Grinevald, 1998; Lapo, 2002). These lectures were attended by his younger French colleagues, the philosopher Edouard Le Roy (1870-1954) and the paleontologist P. Teilhard de Chardin (1881-1955). This important circumstance will be discussed in Chapter 3 in the context of Vernadsky's noosphere. Based on his lectures at the



Sorbonne, Vernadsky published in French the book *La Géochimie* (1924), which represented “his synthesis of the new science of geochemistry” (Bailes, 1990, p. 162), and later was translated and published as *Essays on Geochemistry* in Russian (1927), German (1930), and Japanese (1933).

Vernadsky’s stay in Paris during 1922-1925 was extremely productive. In addition to teaching and developing the new science of biogeochemistry, Vernadsky also worked at the National Museum of Natural History and conducted research with Marie Curie at the Institute of Radium. Simultaneously, he worked on the manuscript of his ground-breaking book *The Biosphere* that was published shortly thereafter in Russian (1926) and in French (1929). Vernadsky also gave a lecture course on biogeochemistry in Prague in 1926. From Europe, Vernadsky’s ideas spread all over the world, but largely without open attribution.

### **The First English Translation of *The Biosphere***

Someone could wonder why it was that the first English translation of Vernadsky’s *The Biosphere* was published precisely in 1986, but not earlier or later. There were, perhaps, two major reasons for this. On the one hand, prior to 1986 the compartmentalization of knowledge and extreme specialization of research, typical in the 20<sup>th</sup> century, ensured that a majority of people, including the intellectual elite, were not ready to grasp the cosmic view of Earth as a unique, complex, and dynamic living system – a concept that was embodied in Vernadsky’s theory of the biosphere.

This situation changed dramatically when the Apollo’s first pictures of the “blue marble” were taken from space and popularized through mass media. On December 24,

1968, the famous “Earthrise” picture of our planet was taken by the Apollo 8 lunar mission during orbiting the moon. In December, 1972, another well-known picture of the “Full Earth” or the “Blue Marble” was captured by the Apollo 17 crew travelling toward the moon. These first pictures of our planet enabled many people to visualize our home planet as an oasis, a unique living planet in the dark vastness of the universe. And this is exactly what Vernadsky envisioned and scientifically described in his book *The Biosphere* (1926) and conveyed in his lectures for students, scholars, and the public, both in Russia and abroad. Notably, the first chapter in his book was entitled “The Biosphere in the Cosmic Medium” and started with the following words (Vernadsky, 1926):

The face of the Earth viewed from celestial space presents a unique appearance, different from all other heavenly bodies. The surface that separates the planet from the cosmic medium is the *biosphere*, visible principally because of light from the sun, although it receives an infinite number of other radiations from space, of which only a small fraction is visible to us. Our understanding is full of gaps, but improved detectors are rapidly expanding our knowledge of their existence and variety. Certainly they make the empty cosmic regions different from ideal space of geometry!

On the other hand, the English translation of Vernadsky’s *The Biosphere* was published not later than 1986 because exactly by this time a group of visionaries and enthusiasts led by John Allen had been looking for a theoretical framework for their breakthrough project on the designing, constructing, and testing of an artificial biosphere, which they called Biosphere 2, assuming that our planet Earth possesses the only known biosphere yet, i.e. Biosphere 1.

## **The Biosphere 2 Project**

That was a time of quickly progressing space research, which imposed the question of the future exploration of other planets inhospitable to human life and, consequently, the need for artificially created miniature “biospheres” that astronauts could set up and use on-site. To meet this challenge, Allen and his collaborators needed a solid scientific framework to build into their project, and after extensive inquiry, they found that Vernadsky’s theoretical system, elaborated 60 years earlier, was the best “conceptual model of Earth’s biosphere” available (Allen, 1990). Their search for a theoretical model thus caused the first, abridged English translation of *The Biosphere* to be published in 1986. As Margulis et al. (1998) described this later, “Demand for the voice of Vernadsky himself in English was given a boost by the Biosphere 2 project” (p. 16). In Allen’s own words (1990),

The Russian scientific tradition is quite interesting in the equal emphasis it gives to Konstantin Tsiolkovsky, a founder of astronautics, and Vladimir Vernadsky, who laid the scientific basis for understanding the biosphere. Tsiolkovsky developed, along with Goddard in our country, the practical foundations of the idea of rocketing into space. Vernadsky pointed out that life itself is a tremendously powerful geological force, far more than the common perception of it as a thin shell surrounding a small planet. He saw life and the biosphere as a cosmic phenomenon, both because it fundamentally depended on cosmic energy coming in as solar radiation and because it was an immensely powerful force that could transform the surfaces of planets. Vernadsky came to the same conclusion as Tsiolkovsky, namely that biospheres were destined to go into space, outgrowing their planetary cradle here on Earth. By 1969 the famous photographs of the blue planet seen from space had begun to change the way all of us thought and felt about the Earth, leading to a flowering of studies of planetary ecology. G.E. Hutchinson of Yale, who was a great American student of Vernadsky, edited the influential Scientific American volume *The Biosphere* published in 1970. But still many questions remained. How, actually, could you put a conceptual model of Earth’s biosphere together, containing and regulating as it does such vast, marvelous and evolving complex systems?

The unique Biosphere 2 experiment “was designed to replicate Biosphere 1 – [i.e.] the Earth – in its ecological process as well as humans set to live inside it” (Jusinski, 2009). In 1991, eight people – the “biospherians” – were sealed for two years in a three acre facility constructed in the Arizona desert. This structure contained a rainforest, a shallow ocean with a coral reef, a desert, a savanna, an intensive agricultural area, and living quarters for the inhabitants. The mission was a complete success and substantially advanced our understanding of how “energetically open, materially closed life systems, natural or artificial, and capable of long term self-renewal” actually work (Biosphere Foundation, 2006).

Just recently, the inventor of Biosphere 2, John Allen, published a beautiful book, *Me and the Biospheres: A Memoir by the Inventor of Biosphere 2* (Allen, 2009), which is a captivating narrative about his fascinating life and the Biosphere 2 project that became his life’s work. Among others, the book contains Vernadsky’s portrait with a short comment: “Vladimir Vernadsky, great biogeochemist, founder of biospherics, a genuine hero of thought and action.” Like Vernadsky himself, Allen and his group of innovators were much ahead of their time and their historical experiment will surely gain increased recognition as time passes, together with knowledge they acquired on the working of the isolated and artificial life system – Biosphere 2.

### **Vernadsky’s Publications and His Growing Popularity in the West**

By the time the Biosphere 2 project started, several English-language books about Vernadsky’s life and work were published. Among them, there was *Vladimir Vernadsky* by Rudolph K. Balandin (1982), a translation from the 1979 Russian edition that

represents a captivating narrative about Vernadsky's personality and lifelong scholarly work.

Andrei V. Lapo published the book *Traces of Bygone Biospheres*, first in Russian (1979) and then in English (1982, 1987). It is “an excellent account of the scientific insights of Vernadsky, his colleagues and students” (Margulis et al., 1998, p. 16) on the biosphere and co-evolution of the living and non-living components of the biosphere. The title of Lapo's book, *Traces of Bygone Biospheres*, represents in fact one of Vernadsky's many famous expressions – “Vladimir Vernadsky's immortal phrase” by definition of Margulis and Sagan (2003, p. 96) – as it concisely communicates the nature of life as an active geological force forming the face of our planet through its entire history.

American historian of science Kendall E. Bailes (1990) published his book *Science and Russian Culture in an Age of Revolutions: V.I. Vernadsky and his Scientific School, 1863-1945*. It represents thorough research not only on Vernadsky and his scientific school, but also on Vernadsky's biography and personality in the context of the dramatic periods of Russian history he lived through. Indeed, Vernadsky's life started in Tsarist imperial Russia, and ended up in the Stalinist Soviet Union. However, although this remarkable study is well known to historians of science, it remains largely unknown to scientists. Thus, the science citation index (SCI), as of February 24, 2010, shows 33 citations for this outstanding book, all of which relate to the history or to the history and philosophy of science, with only five of them concerned with scientific sources (two citations) and the interface of science with humanities and/or social sciences (three citations) (Web of Science, 2010).

In 1999, the book *The Noosphere Reader: Global Environment, Society and Change* was published under the editing of Paul S. Samson and David Pitt. This volume represents a collection of excerpts from the works of many, past and present, outstanding scientists and thinkers including Vladimir Vernadsky. The book is an attempt to trace “the emergence of the concepts of noosphere and biosphere within the context of environmental change” (Samson & Pitt, 1999). Although the book could be praised for the number of diverse authors and perspectives presented, someone could find it rather disappointing because none of the contributing authors’ articles is presented in full but often in significantly abridged version.

Based on his doctoral thesis/dissertation/work, George S. Levit (2001) published the book *Biochemistry–Biosphere–Noosphere: The Growth of the Theoretical System of Vladimir Ivanovich Vernadsky* – the most thorough research on Vernadsky’s theoretical legacy available in English until now. Levit shows that Vernadsky created “a theoretical system all parts of which are intimately interconnected. Each part of this system is relatively autonomous but its significance can only be fully understood in the context of the whole theoretical system” (p. 15), which is “a conceptual structure embracing different sides of his theoretical activity” (p. 16). Levit considered Vernadsky’s theoretical system both from historical and philosophical perspectives, and compared it to the other global theories. As Petr Rezvykh (2004) points out, it “is a very good introduction to reading Vernadsky” that “provides a correct summary of Vernadsky’s main ideas” (p. 62).

Another outstanding Vernadsky-related work is Vaclav Smil’s book *The Earth’s Biosphere: Evolution, Dynamics and Change* (2002). The first chapter of the book,

entitled “Evolution of the Idea: From Vernadsky to a Science of the Global Environment,” accurately conveys the history of the emergence of the biosphere concept and its importance for today. In addition, the book represents in fact a comprehensive update on the global ecology, or the “science of the biosphere” in Vernadsky’s definition, and could be strongly recommended to English-language readers.

As to Vernadsky’s original work, during recent years more of his major writings have been published in English. The first complete English-language publication of Vernadsky’s *The Biosphere*, a translation from the French edition of his book (Vernadsky, 1929), saw the light only in 1998. In its forward, a group of 13 leading scientists from 12 countries, including such authorities as Lynn Margulis and David Suzuki, paid a sound tribute to Vernadsky and his theoretical legacy (Margulis et al., 1998). Jacques Grinevald, an internationally-known historian and philosopher of science and a key expert on the biosphere, wrote a brilliant introduction, “The invisibility of the Vernadskian revolution.” According to Grinevald, “Now the time is ripe for the revival of the real historical figure of Vernadsky and his complete work on the Biosphere.”

At the same time as the full English translation of his *The Biosphere* was finally published in 1998, another very important book of Vernadsky, *Scientific Thought as a Planetary Phenomenon*, was published in English (Vernadsky, 1997) by the Nongovernmental Ecological V.I. Vernadsky Foundation in Russia. Vernadsky worked on this book beginning from the early 1930s with the idea to express philosophically his holistic view of nature including the biosphere (Levit, 2001; Lapo, 2001). However, the book was not published during Vernadsky’s life and was released in Russia only posthumously, first as an abridged version in 1977 and, finally, in complete form in 1991.

Although *Scientific Thought as a Planetary Phenomenon* was later translated into English and published in Moscow in 1997, it remained almost unnoticeable in the West. One of the reasons for this could be that it was not promoted in the West and, therefore, was out of sight for an English-reading audience. For example, even today (March 11, 2010) it cannot be found on the Amazon.com web site, which is the most popular Internet search engine for books.

Likewise, the science scientific index (SCI) provides only five citations for the Russian edition of *Scientific Thought as a Planetary Phenomenon* (1991) and zero result for its English translation of 1997 (The Web of Science, 2010, retrieved on February 5, 2010). Moreover, three of the above five citations are made by Russian authors (although their articles are published in international English-language journals); the other two citations are included in western scholars' papers but with Levit as the first author, who is presumably able to use Russian-language sources because he refers extensively to them in his profound research on Vernadsky, part of which he has conducted in Russia (Levit, 2001). Thus, *Scientific Thought as a Planetary Phenomenon* is in fact still inaccessible to the western readers and, as the SCI shows, this important Vernadsky work is practically unknown to the English-language audience.

At the same time *Scientific Thought as a Planetary Phenomenon* was already published in Italy (1995) and Germany (1997), as Andrei V. Lapo points out (2001). The reason that an English translation of *Scientific Thought as a Planetary Phenomenon* was not published in the West until now might be that the time for it had not yet come. Indeed, in the case of Vernadsky's *The Biosphere* (1926), it took 60 years for the West to



publish its English abridged translation (1986) and 72 years to release the complete English edition (1998).

It also took also almost 100 years for the West to start to realize the importance of Vernadsky's breakthrough ideas and fully accept him as a pioneer in many aspects of modern science and thought, and on larger scale of our modern worldview. Do we need another 100 years to understand Vernadsky's cosmic vision of the further evolutionary path of humanity and its important mission as a conscious element of the Earth's biosphere? I do not think so. The global movement of collective human awakening is obviously on the way. It manifests itself through explosive growth of interest, rapidly multiplying organizations/websites, and activities directed toward self-improvement and spirituality, social and ecological justice, the need to understand self and others, to unite and communicate. This question will be discussed more specifically in the following chapters.

And finally, in 2007 Vernadsky's second major work, *Essays on Geochemistry* (1924, 1927), was translated into English and published in one volume with translations of the third Russian edition of *The Biosphere* (1963) and the essay "Some Words About the Noosphere" (1943). As Deborah Snyder, Chief Executive of Synergetic Press that published the book, observed (Snyder, 2010):

The publication of these essays, written over sixty years ago, comes at an auspicious time. We have reached a point on our planet when serious debate on what to do about global warming can no longer be postponed – an understanding of Vernadsky's work on the biosphere and noosphere is absolutely central to such conversations. It is our hope that bringing Vernadsky's ecological vision to the English-speaking world will help deepen our understanding of planetary processes and enable us to become better stewards of our planet.

This long-awaited release of *Geochemistry and the Biosphere; Essays by Vladimir I. Vernadsky* (Vernadsky, 2007) is a compact representation of Vernadsky's major ideas and is "highly recommended for upper-division undergraduates through professionals" (Kormondy, 2007).

### **Some Negative Effects of Not Reading Vernadsky's Original Writings**

In Russia, we say that, no matter what, history has a way of putting everything in its proper place. There are numerous examples from the history of science illustrating this observation, as it was for instance with Mendeleev's periodical table or Vernadsky's theoretical system today. Indeed, it seems that Vernadsky's popularity in the West is growing and his theoretical legacy acquiring appropriate stature in modern science and intellectual life. Nevertheless, there are some negative effects associated with this positive trend. Unfortunately not all secondary materials available in English transmit accurately Vernadsky's ideas and what is known of his life.

It is necessary to emphasize, therefore, that the best way to be acquainted with Vernadsky's ideas is to read his own writings, i.e. originals that are fortunately available in English, rather than relying on secondary accounts (the list of English-language publications of Vernadsky's original work is given in Appendix 1). Some authors, who are not familiar with Vernadsky's original writings, can misunderstand or even misinterpret some of Vernadsky's ideas or thoughts.

For example, the fact that Vernadsky is cited in the "Noosphere" article (Jäger, 2008) of the recently published *Encyclopedia of Ecology* (Jørgensen & Fath, 2008) would be highly welcomed, if the information provided did not misrepresent the truth. Thus, C.

Jäger writes that “In the 1920s, Vernadsky was staying in Paris where he met the philosopher and mathematician Edouard Le Roy, whose lectures on biogeochemistry he attended. Through Le Roy, Vernadsky got exposed to a concept that Teilhard de Chardin, who also attended Le Roy’s lectures, was developing in those days: the concept of the noosphere” (Jäger, 2008, p. 2534). The only truth here is that Vernadsky indeed stayed in Paris during 1922-1925. The rest of Jäger’s above quote (p. 2534) is erroneous because:

1. Le Roy never delivered lectures on biogeochemistry – a new science that Vernadsky was founding at that time which is widely recognized and exceedingly discussed in western literature (e.g. Bailes, 1990; Levit, 2001; Smil, 2002);
2. Not Vernadsky, but Le Roy and Teilhard had been attending two lecture courses on geochemistry Vernadsky taught at the Sorbonne in winter 1922-1923 and in 1924, which is well documented by authoritative western historians of science like Bailes (1990) and Grinevald (1996, 1998, 1998a);
3. The concept of the noosphere was conceived during numerous academic discussions between Vernadsky, Le Roy and Teilhard, at the time they attended his lectures (Bailes, 1991; Grinevald, 1996, 1998, 1998a; Smil, 2002). Le Roy, building on Vernadsky’s lectures and discussions with Vernadsky and Teilhard, “came up with the term noosphere”, which he introduced in his lectures at the College de France in 1927 (Le Roy, 1927)” (Smil, 2002). As it will be discussed in Chapter 3 when considering Vernadsky’s noosphere, Le Roy paid credit to Vernadsky for the idea he and Teilhard received from Vernadsky’ lectures and the following discussions of these three (Grinevald, 1998a).

According to the new discipline of Ethics in Scholarship and Research that emerged recently in an academic environment as a response to the unprecedented degree of fraud (either intentional or unintentional) in modern science and scholarship, the above

example definitely falls under the category of academic misbehavior because of the misrepresentation of scientific record.

It seems that Jäger (2008) did not research sufficiently the question of the noosphere concept and, specifically, the history of its evolution. It is sad that at the time when people are looking for ecological knowledge which they can apply practically in their personal and professional lives, there are “scholars” like Jäger (Jaeger)<sup>5</sup> who do not take their time to research the subject thoroughly but provide misleading information or sometimes even pure lies for the readers. Meanwhile, Jäger provides the reference for Vernadsky’s “The Biosphere and the Noosphere” paper in *American Scientist* (1945), in which Vernadsky described the story of his academic relations with Le Roy and Teilhard. Someone could wonder: did Jäger himself read the paper he cites?

Ironically, Jäger’s misinformation is included in and protected by the authoritative and desperately needed, first edition of *Encyclopedia of Ecology* (Jørgensen & Fath, 2008), which is advertised in similar ways both at the Amazon.com and the original *Encyclopedia of Ecology* website (2010): “Written by an international team of leading experts, this revolutionary encyclopedia will serve as a one-stop-shop to concise, stand-alone articles to be used as a point of entry for undergraduate students, or as a tool for active researchers looking for the latest information in the field” (Amazon, 2010). By the way, this information costs something: the five-volume edition of *Encyclopedia of Ecology* (Jørgensen & Fath, 2008), as of March 9, 2010, costs \$2,717.27 new and from \$3,225.52 used. The price definitely manifests that ecological information is in

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<sup>5</sup>Prof. Dr. Carlo C. Jaeger, Head of research domain Transdisciplinary Concepts & Methods, Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany, <http://www.pik-potsdam.de/members/cjaeger> - retrieved on March 9, 2010.

demand now, which is great. It is sad, though, that at least one of the 500 articles of this extremely important and timely publication contains inaccurate/erroneous information.

The good news is that there are a number of good quality papers and articles about Vernadsky and his theoretical system available in English. I provide in Appendix 2 a list of some accurate and well-researched publications that have been issued in English, along with the list of English-language publications of Vernadsky's original work given in Appendix 1.

### **Vernadsky's Acknowledgement in Russia: a Historical Sketch**

Today Vernadsky is extremely popular in Russia. Most of all, he is popular within academia which he contributed to enormously with his pioneering ideas and research which encompassed many old and new, special and interdisciplinary, theoretical and applied fields. These ideas and the research programs which he began were further developed by his numerous intellectual successors. Thus, Vernadsky-related research is successfully continuing in both special and interdisciplinary fields ranging from philosophy and history of science to mathematical modeling, earth sciences, and sustainability education, just to mention a few. His legacy lives also in a number of scientific institutions he founded or organized during his life, and which outlived him and grew in size to become major research institutions not only at national but at a global level. Among them, for example, are the Ukrainian Academy of Sciences (1919)<sup>6</sup>, the Radium Institute (1922), and the Laboratory/Section on Living Substances (1927) which

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<sup>6</sup> Parentheses indicate the year of foundation.

is now the V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, just to mention a few.

Furthermore, beginning in the late 1990s it has become the norm that Vernadsky is cited at the highest governmental levels and his ideas are acknowledged in national environmental policy (Oldfield, 2001; Oldfield & Shaw, 2002, 2006; Yanshin, 2002). Vernadsky's concepts of the biosphere and the noosphere are formally incorporated in the general education system of the Russian Federation, which will be considered in Chapter 4. There are also a number of nongovernmental and nonprofit organizations concerned, for example, with conservation issues, social and ecological justice, ethics and philosophy, which use Vernadsky's thought as a conceptual framework in their activities, both in Russia and across the globe.

However, Vernadsky was not always well known and popular among Russians during the communist period. When the Great October Socialist Revolution of 1917 took place, Vernadsky was already an internationally recognized scientist of 54, and had been a member of the Imperial Academy of Sciences<sup>7</sup> for the preceding 12 years. Under the tsarist regime, he was politically active and held one of the key positions in the Cadet Party (Constitutional Democrats Party); during a short period between the abdication of Tsar Nicholas II in March 1917 and the October Revolution, he served as an assistant minister of education in the Provisional Government. This alone would have been enough for Bolsheviks to shoot him after they came to power, but he was able to escape to Ukraine, although he almost died there of typhus. He survived, but resigned from his

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<sup>7</sup> In Russian tradition, the highest rank possible for the outstanding achievements in the advancement of science. Beginning from the Soviet period, this highest title of honor in academia has been usually called an *Academician*. It was unusual to receive this rank at the age of 42 as Vernadsky did, because typically this title was awarded to exclusively to elderly scholars.

party, “feeling himself ‘morally incapable of participating in civil war’” (Vernadsky, 1998, p. 154).

He could easily have been among the many emigrants in his circles who left Russia forever after the defeat of the White Army in the Civil War, but he remained in Russia. British colleagues offered him the opportunity to continue his work in Britain, and arranged passage on a British vessel from the Crimea. The ship waited several days off the coast, but Vernadsky decided he could not leave. Later, both of his children immigrated via Europe to the United States. His son George was for 40 years a professor of Russian history at Yale, and his daughter Nina worked as a psychiatrist.

Vernadsky managed to survive all turmoil of the Russian Revolution and the Civil War, and moreover, was able miraculously to use this time of chaos and destruction to continue developing his ideas on biogeochemistry and the biosphere, and to organize scientific institutions and research labs. For example, he was the founder and the first president of the Ukrainian Academy of Sciences; he also founded the Ukrainian National Library in Kiev and the “first biogeochemical laboratory in the history of natural science” (Levit, 2002, p.11).

He never had any sympathy for the communist regime, which he criticized regularly in his diary, itself a very dangerous thing to do. Moreover, under Stalin, Vernadsky courageously tried to help his colleagues and friends who had been arrested and repressed, by writing letters to the highest authorities. By doing this, he certainly risked his own life, but he was neither arrested nor killed. Why? In part because he was a world-renowned scientist but, more importantly, because he was needed by the state for his involvement in research and projects of strategic importance which he had initiated.

For example, in 1914 he organized and since then headed the Commission for the Study of Natural Productive Forces [i.e. natural resources] of Russia (KEPS); he “was one of the first to recognize radioactivity as a powerful, untapped source of energy and laid the foundation for radiogeology” (Kauffman, 1991, p. 320) and organized work on exploration of uranium ores in Russia. In view of the WW2 threats, on Vernadsky’s initiative a Uranium Commission of the Academy of Sciences was created in 1940, which later included the secret Soviet atomic weapon program. The authorities valued him as a scientist, but not as a citizen with trustworthy political views. As Margulis et al. (1998, p.14) summarized it, “Through the political morass of the Stalinist Soviet Union, Vernadsky remained vigilant towards honesty, indifferent to politics, and devoted to open scientific inquiry.”

After the denunciation of Stalin’s cult of personality in Russia, Vernadsky and many other outstanding representatives of the Russian intellectual elite who were repressed, silenced or even killed during Stalinism, became known to Russian intellectuals and the public. Since then Vernadsky’s personal fame and that of his theoretical system in the former Soviet Union has been growing continuously.

Western scientists were astonished to learn about Vernadsky’s unprecedented fame in Russia. They point out that Vernadsky “is widely celebrated in Russia and the Ukraine. A monument in his memory in Kiev rivals a Vernadsky Avenue in Moscow. His portrait appears on Russian national stamps, air letters, and even memorial coins” (Margulis et al., 1998, p. 14) and in “the former Soviet Union some fourteen institutes are named after him” (Margulis and Sagan, 2003, p. 127). Stephen M. Rowland (1993, quoted in Margulis et al., 1998) writes:



In the years to come ... Vernadsky's stature is certain to grow. Already named in his honor are a mineral (vernadite), a geologic museum, the Ukrainian central science library, several mountain peaks and ranges, a peninsula in East Antarctica, a submarine volcano, a crater on the back side of the moon, a mine in Siberia, a scientific research vessel, a steamship, a village in Ukraine (Vernadovka), a street in Moscow (Vernadsky Prospekt), and a species of diatoms. Already named in his honor are a mineral (vernadite), a geologic museum, the Ukrainian central science library, several mountain peaks and ranges, a peninsula in East Antarctica, a submarine volcano, a crater on the back side of the moon, a mine in Siberia, a scientific research vessel, a steamship, a village in Ukraine (Vernadovka), a street in Moscow (Vernadsky Prospekt), and a species of diatoms. (p. 14)

This list could be continued with such additions named in his honor as a Moscow Metro station, an avenue in Kiev, a railroad station in central Russia, peaks in Siberia and the Kurile Islands, an Institute of Geochemistry and Analytical Chemistry in the Russian Academy of Sciences, a Biosphere Museum (Russian Academy of Sciences, St.-Petersburg), All-Russia Teenage Readings (The Youth Research Papers' Competition for high school students in Russia), two awards (from the Russian and from the Ukrainian Academies of Sciences) for outstanding achievements in Mineralogy, Geochemistry, and Cosmochemistry, the Nongovernmental Vernadsky Ecological Foundation, the Vernadsky Scholarship Alumni Association (VSAA), an honorable Award Medal "For Contribution to Sustainable Development", the Russian Academy of Sciences Committee on the study of the scientific heritage of academician V.I. Vernadsky (<http://www.tstu.ru/win/kultur/nauka/vernad/imen.htm>).

Why such a great tribute and unprecedented attention to just one, even though an extraordinarily talented, scientist? Is his popularity a result of his tremendous productiveness and immense contribution to modern science in general? Indeed, the following numbers and list of his scientific interests and contributions give an idea of his

breadth, depth, and effectiveness as a researcher and scientist (Pyatibratova, 2000, quoted in <http://www.tstu.ru/win/kultur/nauka/vernad/nasled.htm>):

Of Vernadsky's 416 works that were published during his lifetime, 100 were devoted to mineralogy, 70 – biochemistry, 50 – geochemistry, 43 – history of science, 37 – organization of science, 29 – crystallography, 21 – radiogeology, 14 – soil science, and the rest – to different questions of science, history, philosophy, etc.

Many of Vernadsky's works were published after his death. The most complete bibliography of Vernadsky's scientific work published prior to 1991 contains 682 published works of Vernadsky, as well as 914 publications about Vernadsky (IAnshin et al., 1992, quoted in <http://www.tstu.ru/win/kultur/nauka/vernad/nasled.htm>). As of February 14, 2010, the website of the Tambov State Technical University's Museum of Science, named after Vernadsky, states that his published works exceed 700.

Indeed, the prediction by Alexander Fersman, Vladimir Vernadsky's closest pupil and his successor in the area of geochemistry, seems to be coming true. In 1945 Fersman wrote about Vernadsky: "His general ideas will be studied and elaborated during centuries and one will discover new pages in his works which will serve as the source for new searches. Many scientists will learn his creative thought which is acute, stubborn and articulated, always genial, but sometimes poorly understood. As for young generations, he always will be a teacher in science and a striking example of a fruitfully lived life" (Fersman, 1946; The Prominent Russian Scientist V.I. Vernadsky, 2010).

### Vernadsky's Legacy Today

Ten years ago Andrei V. Lapo (2001) regretted that, although Vernadsky's popularity grew all over the world, not all of his major works were published in the West, which is why either he or his work were still often unknown to the English-speaking reader. Using the science citation index (SCI), Lapo compared the number of citations for Darwin and Vernadsky and found that there were 446 citations for Darwin and only 19 citations for Vernadsky in 1988 (Lapo, 2001). Since then, the situation concerning Vernadsky's citations has changed dramatically (Table 1). As of February 2010, there were 335 citations for Vernadsky and 690 citations for Darwin (The Web of Science, 2010), which means that over the past 12 years a number of Vernadsky's citations increased by 17.6 times, while the number of Darwin's citations increased by 1.7 times<sup>8</sup>.

Table 1

*Number of citations (SCI) for Darwin and Vernadsky in 1988 and 2010*

Science Citation Index (SCI)	1988 (data quoted in Lapo, 2001)	2010
Vernadsky V.I.	19	335
Darwin C.R.	446	690

It is remarkable that Vernadsky's theory of the biosphere and noosphere and its importance have recently been appreciated and reflected upon by western scholars in many specific and interdisciplinary fields, such as

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<sup>8</sup> This growth in Darwin's citations during 1998-2010 could be partially explained by the globally-wide celebration of both Darwin's 200<sup>th</sup> birthday and 150-year anniversary of his *Origin of Species* in 2009.

- biophysics (Tennenbaum, 2005)
- biospherics<sup>9</sup> (Allen, 1990, 2000, 2009; Jusinski, 2009)
- Earth system science (Wakeford, 1999; Westbroek, 2002; Pitman, 2005; Ellis and Bledzki, 2009)
- ecological literacy and education (Orr, 1992; Trubetskova, 2009)
- ecological modeling (Svirezhev, 1998)
- ecology (Hutchinson, 1970; Odum, 1989; Cancela da Fonseca, 2000)
- economics/economy, finances, and politics (LaRouche, 2001, 2005; Spannaus, 2005; Tennenbaum, 2005)
- environmental studies and pedagogy (Thomashow, 2002)
- evolutionary biology (Margulis & Sagan, 2002; Sahtouris, 2000)
- environmental policy (Rifkin, 1991; Oldfield, 2001; Oldfield et al., 2003; Oldfield & Shaw, 2002, 2006)
- cybernetics<sup>10</sup> (Levit, Hossfeld & Olsson, 2006; Abraham, 2007)
- fine arts and the evolution of our perception of aesthetic space (Korsakova-Kreyn, 2009)
- geochemistry (Behrends, 2005)
- geography and environmental science (Wakeford, 1999)
- global ecology or “the science of the biosphere” (Vernadsky’s term) update (Smil, 2002)
- history and philosophy of science (Bailes, 1990; Grinevald, 1998; Levit, 2001)
- mathematical/computer modeling (von Bloh, 2006)
- microbiology (Piqueras, 1998)
- noospherics<sup>11</sup> (Allen, 2000; Summary, 2004; Noosphere II, 2010)

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<sup>9</sup> “Biospherics is the study of all kinds of biospheres: an exciting and essential new science, first envisioned by Vladimir Vernadsky (Russia) in the 1920's. Biospherics differs from systems ecology in that it deals with materially closed systems and thus complete biogeochemical cycling. Biospheres, as a class of objects to study, are defined as energetically open, materially closed life systems, natural or artificial, and capable of long term self-renewal. Biospheric closed systems include the project Biosphere 2, its test module, and recently a 1400 cu ft structure called the ‘Laboratory Biosphere’” (Biosphere Foundation, 2006).

<sup>10</sup> Cybernetics – the theoretical study of communication and control processes in biological, mechanical, and electronic systems, especially the comparison of these processes in biological and artificial systems. (<http://www.thefreedictionary.com/cybernetics>, retrieved on February 27, 2010).

- philosophy (Abraham, 2009; Smith, 2009)
- political and economic security (Rifkin, 1991)
- science, philosophy, and politics (Bailes, 1981, 1990)
- semiotics<sup>12</sup> (Mandelker, 1994)
- sustainability science (Clark et al. 2004)
- sustainable development (Oldfield & Shaw, 2006)
- theology, history, and philosophy (Oderberg, 1998).

Although this list is far from being comprehensive, it gives an idea of the scope of Vernadsky's intellect and relevance of his work to our present time. This brief listing also clearly shows that Vernadsky's ideas resonate strongly with contemporary research across a whole spectrum of disciplines, and have both theoretical and applied significance. It also shows the multi- and inter-disciplinary character of his research and expertise as a scholar and thinker, and most astonishing – the capacity of his mind for synthesis. As early as the beginning of the 20<sup>th</sup> century, when sufficient quantitative data on the functioning of the biosphere and space research and photography were not yet available, his attempt to comprehend all existing scientific knowledge and insights to build a conceptual model of the Earth as a complex and integral living system in space and time has resulted in the generation of an integrative and holistic theoretical system that is scientifically alive and important today.

There has also been explosive growth of Vernadsky-related references or web pages in the Internet over the last few years. Table 2 shows that from 2007 to 2010 the number of Internet searches for Vladimir Vernadsky grew from 59,700 to 144,000 for

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<sup>12</sup> Semiotics, or semiology, is the study of signs, symbols, and signification. It is the study of how meaning is created, not what it is ([http://www.uvm.edu/~tstreete/semiotics\\_and\\_ads/terminology.html](http://www.uvm.edu/~tstreete/semiotics_and_ads/terminology.html), retrieved on February 27, 2010).

number of Internet searches for Vladimir Vernadsky grew from 59,700 to 144,000 for English-language sources (Google search engine), and increased from 27,291 to 827,000 for the Russian-language Internet (Jandex). The table also demonstrates clearly that rapid and spontaneous growth of Vernadsky-related Internet references continues right now at the rate of approximately 32,000 new searches per month in the English Internet (Google) and of about 114,000 in the Russian Internet (Jandex).

Table 2

*A comparison of the number of searches for Vladimir Vernadsky using English- and Russian-language search engines for 2007 and 2010*

Internet Search Engine	Date/Search Results			
	2007		2010	
	05/27	02/03	03/03	03/06
English Internet (Google) search: <i>Vladimir Vernadsky</i>	59,700	102,000	133, 000	144,000
Russian Internet (Jandex) search: <i>Владимир Вернадский</i> ( <i>Vladimir Vernadsky</i> )	27,291	735,000	849,000	856,000

Thus the dynamics of the Internet references, the science citation index/SCI, and the increasing number of Vernadsky-related publications over the last few years shows obvious growth of the popularity of his Theoretical System and his personality. With certainty, it could be expected that in the years to come the legacy of Vladimir Vernadsky will become more known and popular all over the world because this is exactly the right time – the crucial time in the evolution of humanity when it is yet possible to switch its path from a self-destructive to a balanced and sustainable mode; because this is the time

when a holistic and ecological worldview – a roadmap that would help humanity optimistically and mindfully enter the future – is in demand; because this is the time when people are coming to the realization that this roadmap in the future, so desperately needed right now to unite their efforts on a global level, was ingeniously sketched by Vernadsky for them as far back as the beginning of the 20<sup>th</sup> century.

As any map, though, it provides only general directions and the needed locations, and does not provide all details of the journey that could only be figured out experientially through the act of taking this journey. This roadmap is a conceptual framework designed by Vernadsky to help people understand their past, their present, and their possible future as an organic and conscious part of the biosphere. This turning must be a collective evolutionary journey of humanity and assumes everyone's personal responsibility to make proper decisions and choices to resolve decently all challenges that they face, unintentionally or intentionally, on their way to the future. This is exactly why all students should be introduced to Vernadsky's theoretical system – the issue progressive educators both in the East and in the West raise again and again today (Kormondy, 2007; Rifkin, 2007; Salisbury, 2007; Thomashow, 2002) – which will be examined in the following chapters and, specifically, in Chapter 4.

### CHAPTER III

#### VLADIMIR VERNADSKY'S THEORY OF THE BIOSPHERE AND THE NOOSPHERE: A SCIENTIFIC BASIS FOR SUSTAINABILITY EDUCATION

*I am working well on living matter. Many new ideas in understanding of nature... I'm trying to criticise myself and my research: I acknowledge that the nature has never been considered this way.*

Vladimir Vernadsky, 1918

*Living matter gives the biosphere an extraordinary character, unique in the universe... Cosmic energy determines the pressure of life that can be regarded as the transmission of solar energy to the Earth's surface... Activated by radiation, the matter of the biosphere collects and redistributes solar energy, and converts it ultimately into free energy capable of doing work on Earth... A new character is imparted to the planet by this powerful cosmic force. The radiations that pour upon the Earth cause the biosphere to take on properties unknown to lifeless planetary surfaces, and thus transform the face of the Earth... In its life, its death, and its decomposition an organism circulates its atoms through the biosphere over and over again.*

Vladimir Vernadsky, 1926

*I look forward with great optimism. I think that we undergo not only a historical, but a planetary change as well. We live in a transition to the noosphere.*

Vladimir Vernadsky, 1945

*Creatures on Earth are the fruit of complicated cosmic process and are a necessary and lawful part of a harmonious cosmic mechanism, in which it is known that chance does not exist.*

Vernadsky, 1994

*Vernadsky's La Biosphère must become a classic, within environmental education as well as scientific learning. We should also credit Vladimir Vernadsky with the title of father of global ecology of the biosphere.*

Jacques Grinevald, 1996



*The revolutionary character of the Vernadskian science of the Biosphere was long hidden by the reductionist, overspecialized and compartmentalized scientific knowledge of our time.*

Jacques Grinevald, 1998

*We have reached a point on our planet when serious debate on what to do about global warming can no longer be postponed. An understanding of Vladimir I. Vernadsky's work on the biosphere and noösphere is absolutely central to such conversations. It is our hope that bringing Vernadsky's ecological vision to the English-speaking world will help deepen our understanding of planetary processes and enable us to become better stewards of our planet.*

Synergetic Press, 2007

### **Vernadsky's Biosphere**

#### **A New Look at Life on Earth**

Today, the term biosphere has become a common word and it is used widely not only in science and education, but also by the mass media and by generally educated people. Not many people, however, know what this term in particular means and only a rare few are familiar with the history of the evolution of the biosphere concept or associate it with Vernadsky's name.

For example, my multiple experiences of running workshops and giving presentations both for students (high school, undergraduate and graduate levels), educators, professionals, and the public show that the overwhelming majority of people have never heard of Vernadsky and do not associate the biosphere concept with his name. Moreover, when it comes to the definition of the biosphere, a majority of people would usually associate it with the totality of living organisms which modern ecology terms as the biota of the global ecological system or of the biosphere.

The modern science of ecology defines the biosphere as a totality of living organisms *with* their environment or as the largest ecosystem we know – i.e. the global ecosystem. For example, Grinevald observed (1996, p. 445) that one of the fathers of modern ecology, Eugene P. Odum, included Vernadsky's two first English-language papers (1944, 1945) in the standard bibliography of his *Fundamentals of Ecology* (1971). Odum writes (1989, p. 28) that “**Biosphere** is the widely used term for all of the Earth's ecosystems functioning together on a global scale.” In the spirit of Vernadsky's ideas and using contemporary scientific language, Nicholas Polunin (1980, p. 89) defines the biosphere as the “integrated living and life-supporting system comprising the peripheral envelope of planet Earth together with its surrounding atmosphere so far down, and up, as any form of life exist naturally.” Similarly, Donald VanDeVeer and Christine Pierce, (2003, p. 650) term the biosphere as “those layers of the Earth and the Earth's atmosphere in which living organisms are located.”

Jacques Grinevald (1996, p. 44) emphasizes that “Vernadsky was the first scientist to be concerned with the boundaries of the biosphere as ‘the domain of life’ and he developed a special article in 1937 to ‘the limits of the biosphere’.” Fidan Yanshina and Alexander Yanshin (1990, p. 289) point out that “Vernadsky defined the limits of the biosphere, showing that it incorporates the entire hydrosphere of the earth, the upper part of the lithosphere, to a depth of 2 to 3 km where living bacteria still occur, and the lower part of the atmosphere.” Also, in Vernadsky's own words (1926; 1998, p. 47), the “biosphere may be regarded as a region of transformers that convert cosmic radiations into active energy of electrical, mechanical, thermal and other forms.”

Vernadsky was a pioneer in viewing the Earth from this perspective – as a unique planet possessing a specific geological envelope occupied by life and transforming solar radiation that is functioning as an integrative and dynamic self-regulatory system (Levit, 2001; Yanshin & Yanshina, 1990; Yanshin, 2007). “According to Vernadsky, the Biosphere is not only ‘the face of Earth’ but is the global dynamic system transforming our planet since the beginning of biological time” (Grinevald, 1998, p. 25). Yanshin (2007, p. xxiv) also points that in “Vernadsky’s understanding, the biosphere is [also] a historic concept. It dates back to the first manifestations of life on earth – manifestations that created atmosphere and changed the planet’s surface in the course of life evolution.” Vernadsky called the “layers of the Earth crust that undergone the influence of biogeochemical activity throughout the entire geological history” as “bygone biospheres” (ibid. p. xxv).

Thus, as early as at the beginning of the 20<sup>th</sup> century Vernadsky elaborated these innovative insights into the biosphere theory which is at the core of the modern scientific paradigm. This is why Hutchinson (1970), one of the founding fathers of the science of ecology, observed: “It is essentially Vernadsky’s concept of biosphere... that we accept today.”

Simply formulated as a term (a totality of living organisms *with* their environment), one should keep in mind that the biosphere theory is a complex, multidisciplinary, and holistic theory that incorporates a group of other intimately interconnected theories, which enabled Levit (2001) to name Vernadsky’s biosphere theory as the theoretical system or “megatheory” (p. 16). Indeed, Vernadsky’s biosphere “is an interdisciplinary concept for integrating astronomy, geophysics, meteorology,

biogeography, evolution, geology, geochemistry, hydrology and, generally speaking, all life and earth sciences” (Biosphere, 2010).

Vernadsky developed his concept of the biosphere using the whole range of knowledge available in his time as well as his own pioneering research in many fields. However, it was not just a question of synthesizing available knowledge from a range of disciplines or a result of a new level of critical and analytical thinking, but it also took multi- and interdisciplinary skills, systems thinking, and above all, a unique and holistic mindset together to create quite a new vision of reality – a new scientific paradigm or a new worldview taken for granted today.

It is necessary to point out that Vernadsky always carefully and scrupulously paid credit to all authors (past and contemporary) whose terms, concepts, ideas, hypotheses, and theories he used in his scholarly work and, in particular, when integrating a number of them into the biosphere theory (Vernadsky, 1924, 1926). Biology professor Frank B. Salisbury, who edited the recently published volume containing English translations of Vernadsky’s two major works, *The Biosphere* and *Essays on Geochemistry*, emphasized in his foreword (Salisbury, 2007, p. vii-viii):

...Vernadsky had a tremendous drive, not only to understand the natural world, but to know those who preceded him in seeking that understanding. As he cites and describes the work of hundreds scientists who came before him, we gain a very broad view of how modern science has developed. Today, many scholars who write textbooks or review a particular topic confine their interests to work done in the preceding few years, or at most, few decades. In contrast, as a historian of science, Vernadsky’s interests stretch back for a few centuries (especially the eighteenth and nineteenth centuries), revealing that the twentieth century (and now the twenty-first) are not alone in producing good facts and ideas. Furthermore, his admiration for those scientists of previous centuries shines through strongly.

As Yanshin observed, “It has been noticed that Vernadsky avoided introducing new terms into science. If necessary, he found them in a scientific literature, which he knew very well” (2007, p. xxxii). Indeed, when creating his biosphere theory, Vernadsky borrowed for example such key terms as biosphere and noosphere from other scholars, whom he always scrupulously paid credit to. He was destined, though, to coin new terms such as biogeochemistry, living matter, cosmochemistry, radiogeology and others – simply because he pioneered research in and, historically, became a founder of these quite new areas of studies that did not exist before. However, because of Vernadsky’s growing popularity worldwide and the realization of the relevance of his biosphere theory to our time, some erroneously assign the authorship of the term biosphere to him.

The term *biosphere* was coined in 1875 by a famous Austrian geologist, Eduard Suess (1831-1914). “In fact, Suess literally tossed the new term away, just once and without an explicit definition, in his pioneering book on the genesis of the Alps (Suess 1875)” (Smil, 2002, p.1). In his interpretation, biosphere is an envelope of life which “is limited to a determined zone at the surface of lithosphere”. The term was never given a definition or elaborated upon until Vladimir Vernadsky created the theory of the biosphere.

Vernadsky developed a complete theory about the biosphere of the planet Earth in two monographs, *The Biosphere* (1926, 1929, 1998) and *Essays on Geochemistry* (1924, 1927, 1930, 2007), and several dozen papers including two English-language articles (Vernadsky, 1944, 1945). It was an entirely new look at life on Earth – a holistic look at Earth as a unique living planet possessing the biosphere – a life-contained and

simultaneously life-supporting system (complex, dynamic, and integral), receiving and transforming solar radiation.

“The biosphere may be regarded as a region of transformers that convert cosmic radiation into active energy in electrical, chemical, mechanical, thermal and other forms,”<sup>13</sup> including human thought or mental energy which is manifested in his noosphere concept (Vernadsky, 1945, 1991, 1997). It was not just a global view of the Earth and its biosphere as a domain of life or geological envelope containing life<sup>14</sup>, but a cosmic perspective when Earth was seen as a planet assimilating and transforming – through its biosphere and in particular, its living matter – solar energy (*Figure 2*).

Before, living organisms were considered as a thin film of life on Earth’s surface that would not have a significant importance in geological processes, and both life and its physical environment were typically not seen as intimately interconnected elements of the same, complex and dynamic, living system. This was Vernadsky who accomplished inter- and cross-disciplinary synthesis using holistic and systems thinking approaches, although these terms did not exist at his time, and Vernadsky is now considered as one of the pioneers in these areas of critical analysis, generalization, and integration.

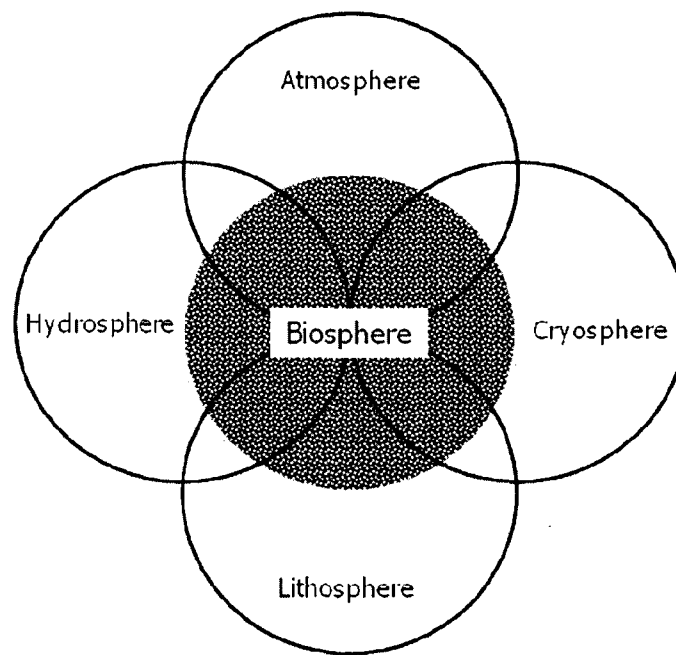
Vernadsky’s “systematic approach to the study of any natural process, permitting depth of interference, is the best exemplar for the integrated research that is so topical today,” as A.L. Yanshin and F.T. Yanshina noted in 1990 (p. 294). Indeed, only recently

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<sup>13</sup> Vernadsky (1965, p. 271), quoted in Bailes (1990, p. 190).

<sup>14</sup> *Biosphere* – the totality of living organisms with their environment, i.e. those layers of the Earth and the Earth’s atmosphere in which living organisms are located; *Atmosphere* – the air/gaseous envelope surrounding the Earth; *Hydrosphere* – the water envelope surrounding the Earth or collective mass of water that is found under, on and over the surface of the Earth; *Cryosphere* is the term which collectively describes the portions of the Earth’s surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps and ice sheets, and frozen ground (which includes permafrost); *Lithosphere* – the outer solid shell of the Earth (Vernadsky, 1926; Odum, 1989; VanDeVeer & Pierce, 2003; Wikipedia Encyclopedia, 2010).

a holistic and systematic approach just started to penetrate the intellectual space of scientific life, which is why the “revolutionary character of the Vernadskian science of the Biosphere was long hidden by the reductionist, overspecialized and compartmentalized scientific knowledge of our time,” as Grinevald wisely observed (1998, p. 27).



*Figure 2.* Diagrammatic representation of Vernadsky’s concept of the biosphere, which is simultaneously a domain of life (or a life-containing geological envelope) and a complex, dynamic, and integral life-supporting system receiving and transforming solar radiation.

At the same time, one should keep in mind that despite his “antireductionist position” (Levit, 2001, p.45), Vernadsky “was criticizing not the productive division of scientific labor but compartmentalization of scientific knowledge, and especially the loss of the united view of nature shared by great naturalists of the past” (Grinevald, 1998, p. 29).

## **Discovering the Living Matter Phenomenon**

It is interesting that initially in his letters and diaries, Vernadsky defined the biosphere as the realm of life, but later and in his publications (1924, 1926) he identified it as the sphere of distribution of living matter (Yanshin & Yanshina, 1990). Here is Vernadsky's own explanation of why he changed terminology (*ibid.* p. 289):

“Living matter”, he wrote, “is a totality of living organisms. This is nothing other than a scientific and empirical generalization of all the countless known, easily and accurately observed, empirically indisputable facts. The concept ‘life’ always overflows the bounds of the concept ‘living matter’ into the realms of philosophy, folklore, religion and artistic creation – all connotations that are no longer present in ‘living matter’” (Vernadsky, 1944, p. 119).

Levit supplements (2001, p. 10):

As early as in 1912 Vernadsky published an important article “On gaseous exchange of the Earth's crust”, where he emphasized that almost all of the Earth's gases are biogenic and involved in the cyclical processes. One has to keep in mind that these ideas were publicized world-wide [in the West] only in 1970-s by J. Lovelock with colleagues (e.g. Lovelock, 1972, 1979; Lovelock & Margulis, 1974). Thus Vernadsky turned his mind on biological phenomena, but in contrast to the general biological approach he was beginning to think of life from viewpoint of geology. Instead of the then existing vague concept of life he started to elaborate his concept of “living matter.”

Y.M. Svirezhev and A. Svirejva-Hopkins (2008) emphasize that Vernadsky's introduction of the concept of living matter was the “first step toward changing the world's picture, as scientists see it now,” and the second step was considering living matter as “cosmoplanetary event” (2008, p. 468).

Guenze V. Guegamian defines Vernadsky's teaching about living matter and the biosphere as the science of biospherology “that can be treated today as a science of the third millennium” (2006, p. 36). He also wrote (*ibid.* p. 35):



With his theory of living matter he was also the first in the history of science to place life in the proper position in the great picture in the universe and discovered fundamental laws which control geochemical activities of living matter in the biosphere. In the first half of the previous century V.I. Vernadsky founded vitally important science for the future of mankind that we have named biospherology.

Guegamian points out that although the “concept of living matter is the cornerstone of Vernadsky’s biospherology”, it “has not been discussed enough” in Vernadsky-related literature except his followers in the Russian Academy of Sciences (ibid, p.38).

Vernadsky started his work on living matter in 1916 and continued working on it for the rest of his life, Guegamian describes (2006, p. 38):

He himself understood the importance of his ideas and in 1918 noted in his diary: “I am working well on living matter. Many new ideas in understanding of nature... I’m trying to criticise myself and my research: I acknowledge that the nature has never been considered this way.”

Vernadsky characterized in detail the difference between living and non-living or inert matter and summarized it in a table containing 15 statements (1945, p. 2), with the following comment:

...the difference between living matter and inert matter of the biosphere is expressed in a table, here given in compressed form. The differences in this table are not merely differences with regard to energetics and chemical properties. They also involve a fundamental difference in the spacio-temporal manifestations of living and inert matter.

Vernadsky described the fundamental importance of eternal interconnectedness of life (living matter) and its environment (non-living matter or inert matter) in the following excerpt (quoted in Svirezhev & Svirejva-Hopkins, 2008, p. 468):

The Earth cover, Biosphere, while fully embracing the globe, has limits that are strictly determined by the existence of living matter in it – it is postulated by it.

Between its inorganic “lifeless” and living parts, inhabiting it, exists continuous exchange of matter and energy expressed by atomic movement caused by living matter. With the time course, this exchange is expressed by *constantly changing and tending to steady-state equilibrium*.<sup>15</sup> This equilibrium threads through the entire biosphere and this atomic flux to a large extent creates and maintains it. Hence, in this manner and during all geological epochs, Biosphere is connected with the living matter that populates it. And namely by this biospheric flux of atoms and energy the strong planetary cosmic significance of living matter is determined.

Thus, as Levit summarized (2001, p. 57): “living matter shapes the biosphere into a self-regulating system. The biosphere being seen as a self-regulating system embraces both the totality of living organisms (living matter) and their environment to the extent it is involved in the actual process of life, that is, including troposphere, the ocean, and the upper envelopes of the Earth crust, possibly down to the mantle,” for example Vernadsky indicated that “the granite envelope is an area of bygone biospheres” (Vernadsky, 1965, p. 325). Indeed, as Yanshin reflects (2007, p. xxi):

By “biosphere,” Vernadsky meant all layers of the planet, and first of all, the layers of the Earth’s crust, that had undergone the influence of biogeochemical activity throughout its entire geological history. This idea of the historic character of the biosphere was shown rather recently in a large geological, geochemical, and paleontological work, a book by Leningrad geologist Andrey Lapo that was translate into English as *Traces of Bygone Biospheres* (Synergetic Press, 1987).

Vernadsky developed a complete theory about the biosphere of the planet Earth in two monographs and several dozen papers. Vernadsky explicitly defined the difference between living and non-living matter, specified boundaries (limits) of the biosphere, determined the total mass of living matter, calculated the amount of cosmic energy that is absorbed by the biosphere through trapping of solar energy by chlorophyll of green algae, developed a mathematical method for determining the pressure of different types of

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<sup>15</sup> Italicized by Irina Trubetskova (I.T.).

living matter, and determined cycles of chemical elements passing through living organisms of the biosphere, along with many other aspects, features and principles of the functioning of the biosphere, which is, according to Vernadsky, both a geological envelope and a complex, dynamic and self-regulating system of Earth as a living planet.

In Vernadsky's own words (1944), the biosphere is

...a definite geological envelope markedly distinguished from all other geological envelopes of our planet. This is only because it is inhabited by living matter, which reveals itself as a geological force of immense proportions, completely remaking the biosphere and changing its physical, chemical, and mechanical properties, but also because the biosphere is the only envelope of the planet into which energy permeates in a notable way, changing it even more than does living matter.

According to Vernadsky's definition, the Biosphere is the single greatest geological force on Earth, moving, processing, and recycling several billion tons of mass a year.

Vernadsky's "The Biosphere and the Noösphere" paper published in *American Scientist* in 1945, was the first publication about his revolutionary theory of the biosphere and the noosphere in English. This short paper was written in 1943 and reflects the summary of Vernadsky's concept of the biosphere and the noosphere as a planetary and cosmic phenomenon, although he had been working on it during the first quarter of the 20<sup>th</sup> century. His concept of the Biosphere and the Noosphere was expounded upon earlier in multiple and detailed publications in Russian (including the book *Biosfera*, 1926) and its translation into French (*La Biosphère*, 1929), as well as during his research, lecturing, and discussions in Western Europe (1922-1924).

However, Western scientists received opportunity to read the English translation of Vernadsky's *Biosphere* only in 1986 (reduced English translation), i.e. 60 years after

the first publication in Russian or 57 years later than in French. And finally, the first full English translation *The Biosphere* saw the light only in 1998.

The destiny of Vernadsky's other important book, *Essays on Geochemistry* that considers many aspects of the functioning of the biosphere as an integral living system, was even more dramatic. It was first published in French (as *La Géochemie*, 1924), and then in Russian (1927), in German (1930), in Japanese (1933), and in English (an abridged version) only in 2007, i.e. 83 years later than the first publication in French and 80 years later than in Russian. Deborah Snyder (2007), Chief Executive of Synergetic Press that published *Geochemistry and the Biosphere: Essays by Vladimir Vernadsky* in 2007 points out:

We have reached a point on our planet when serious debate on what to do about global warming can no longer be postponed. An understanding of Vladimir I. Vernadsky's work on the biosphere and noösphere is absolutely central to such conversations. It is our hope that bringing Vernadsky's ecological vision to the English-speaking world will help deepen our understanding of planetary processes and enable us to become better stewards of our planet.

Today, Vernadsky's popularity and interest in his work is rapidly growing all over the world and, particularly, in the West because his ideas are so relevant to our time. Indeed, Vernadsky's "synthetic view of the biosphere ultimately embraces the geological, biological, and human forces that change and determine the face of the Earth (Ghilarov, 1995, p. 198). Vernadsky's biosphere theory – an entirely new look at life on Earth – is embodied in the modern scientific paradigm and our worldview that allow us to see life, i.e. living matter including people, as a powerful geological force changing the face of our planet and, simultaneously, as a cosmoplanetary phenomenon.

## **Vladimir Vernadsky, the Cosmic Realist**

The most amazing thing about Vernadsky is his approach to the biosphere as a planetary and cosmic event – a new way of looking at life on Earth – as if he observed the Earth from space, although exploration of space started significantly later. As many other modern intellectuals, Mitchell Thomashow, who is a reputable educator and researcher in the field of environmental science and education, is astonished at Vernadsky's cosmic perspective embodied in his biosphere theory articulated in the 1920s; in his book *Bringing the Biosphere Home: Learning to perceive Global Environmental Change* (2002, p.29) he reflects:

What's particularly remarkable about Vernadsky's work is how he could formulate this biospheric perspective without access to satellite photographs or any of the advanced electronic instrumentation that now is taken for granted. He was the first to conceive of ecology and evolution as planetary sciences.

Meanwhile, the first satellite, *Sputnik* (USSR), was launched only in 1957 and the first cosmonaut, Yuri Gagarin, became the first human in the history of mankind to see the planet Earth from space only in 1961. While circling the Earth on his spacecraft "Vostok-1", Gagarin marveled at the beauty of our planet: "People of the world! Let us safeguard and enhance this beauty – not destroy it!"

Indeed, it is not surprising for us to see images of our planet taken from space in the present day, but for Vernadsky it was impossible:

The famous photos of Earth that we received as a Christmas present from NASA some twenty five years ago have affected our vision of earth and humanity's place in the cosmos profoundly. To understand just how much of an effect they have had, go to your attic or to the public library. Dig out a magazine or newspaper from 1969. Go through it carefully and count the occurrences of the words *global* and *planetary*. You will probably not find them at all. Yet in 1994 most of us have internalized these photographs and are beginning to understand ourselves as global or planetary citizens on a small planet in the midst of an immense cosmos

(González, 1995).

I wonder what grand and dynamic pictures Vernadsky envisioned as early as in the beginning of the 20<sup>th</sup> century, when he came to the understanding that the biosphere, in fact, was a great geological and cosmic force changing the face of the unique, living planet Earth through space and time. Arbatov and Bolshakov (1987) describe Vernadsky's insight: "In the biosphere thesis, the Earth represents itself as a small particle in a gigantic Universe, a minute oasis where under some laws the conditions for life emerged, life which the Earth protects from penetration by Sun's ultra-violet rays."

Balandin also speculated on this topic (1988, p. 8):

His [Vernadsky's] imagination produced stunning pictures. The Earth flying in space around a dazzling Helios as if absorbing radiant energy. Rocks storing some of this energy descend into the Earth's depths. In this way solar rays penetrate the entire stone envelope. And the activities of man transforming the sphere of life are also one of the terrestrial conversions of solar energy.

Vernadsky called himself a "cosmic realist" (Grinevald, 1998, p. 25). He was deeply convinced that "To understand scientifically is to establish the place of the phenomenon within the framework of cosmos as a scientific reality" (Vernadsky, 1997, p. 53). What in particular did Vernadsky mean by the "scientific reality"? Academician Alexander Yanshin (2007, p. xxviii) clarifies:

Reflecting on the structure or the macrostructure of the visible cosmos as an object of scientific study, Vernadsky clearly distinguished 'three separate layers of reality', within which the scientifically stated facts are situated. These three layers of reality, in all probability, differ distinctly from each other in properties of space and time. They penetrate into one another, but they are definitely realms unto themselves, distinctly delimited from one another both in their content and in the methods of studying their manifestations. These layers are the following: the phenomena of cosmic spaces, the planetary phenomena of our visible 'nature', so close to us, and the microscopic realm in which gravity is of secondary

importance. The phenomena of life are observed only in the two latter layers of world reality.

Knowing this, it becomes more understandable how Vernadsky viewed Earth and why he starts the first chapter of his *The Biosphere* (1926), which is entitled “Biosphere in the Cosmos,” with the following words (Vernadsky, 1926, 2007, p. 225):

The face of the Earth, its image in the cosmos as seen from outside, from the depth of infinite celestial space, seems to us absolutely unique, inimitable and distinct from all other heavenly bodies. The face of the Earth exhibits the surface of our planet, its biosphere – its outer domain separating it from its cosmic surroundings. The face of the Earth becomes visible due to light penetrating into it from celestial bodies, especially from the Sun. From all space it gathers an infinite diversity of radiation of which the luminous rays visible to us are only a small part.

That was a new, both geological and cosmic insight – as if he was a researcher and an observer from space examining the planet Earth as a unique living planet. This perspective required him to be an extraordinary scientist and thinker, a person of encyclopedic knowledge and an expert in many fields that Vernadsky in fact was. But it took a dynamic systems thinker and a synthetic theorist (terms and notions that appeared significantly later) to provide the level of abstraction, synthesis, and novelty that is embodied in Vernadsky’s biosphere theory. Levit defined it as *Vernadsky’s theoretical system* or “*megatheory*” because it indeed includes a group of “intimately interconnected” theories (2001, p. 16).

Vernadsky’s biosphere is a highly “interdisciplinary concept for integrating astronomy, geophysics, meteorology, biogeography, evolution, geology, geochemistry, hydrology and, generally speaking, all life and earth sciences” (Synergetic Press, 2007). Svirezhev and Svirejva-Hopkins (2008, p. 467) calls Vernadsky’s biosphere theory a

“verbal [i.e. conceptual] model of the biosphere” and say that the “empirical generalization method” he used is, in modern terms, a typical method of systems analysis.

What is especially striking is that Vernadsky not only as early as the 1920s created a conceptual model of the functioning of Earth as a planet of life, but he also tried, with the lack of data necessary because of the insufficient advancement of science at his time, to quantify the processes involved in the biosphere functioning. For example, he calculated the total mass of living organisms including humans which was between  $10^{20}$  and  $10^{21}$  grams; he “carefully investigated the energy balance of different planets in the solar system and, in particular, the question of the magnitude of the thermal and electromagnetic energy received by the earth from the sun;” he explained the general principles and quantified (wherever it was possible) the distribution of living matter in the biosphere, with special attention to the chlorophyll of green plants as the main transformers of solar energy into chemical energy of the biosphere – just to mention a few (Yanshin & Yanshina, 1990, p. 289).

Levit points out that the “idea of the cosmic nature of life is connected with all the important parts of Vernadsky’s theoretical system” (2001, p. 72). He indicates that Vernadsky’s deep conviction that life is a cosmic phenomenon is based on evidence that “green organisms are adapted, first of all, for its cosmic function;” also, the “fact of the increasing significance of life in the process of our planet shows by itself that life is a cosmic phenomenon” (ibid, p. 72). George Levit (*G.L.*) cites (2001, p. 73) Vernadsky’s own words (Vernadsky, 1965, p. 228):

It is logically inevitable to assume that we can find the same phenomena [life – *G.L.*] on other planets. The large scope of life and its significance on our planet does not allow the contemporary naturalist to think that life is an accidental (as



Wolles [1822-1913] said “providential”) phenomenon, which is not connected with the planetary structure and is not represented in the Cosmos except for Earth.

Vernadsky also observed that “creatures on Earth are the fruit of complicated cosmic process and are a necessary and lawful part of a harmonious cosmic mechanism, in which it is known that chance does not exist” (Vernadsky, 1994, p. 318-319; quoted in Levit, 2001, p. 73). Cosmism of Vernadsky, embodied in his theoretical system, manifests his view of the world that was not only ecocentric (i.e. ecological and holistic) but also cosmocentric, which was partially reflected upon in Chapter 1 and will be considered in the next chapter in regard to the Philosophy of Russian Cosmism of which Vernadsky was a brilliant representative.

Thus, Vernadsky was far ahead of his time in his vision of the Earth as a complex system and simultaneously a sub-system of a greater, cosmic reality. With his concepts of living and nonliving (inert) matter, co-evolution of life and the rest of physical environment on Earth, the complete biosphere theory, and the science of the biogeochemistry, Vernadsky pioneered in the creation of a conceptual model of the functioning of the Earth biosphere as a complex, integral, self-regulating system in space and time.

### **Vernadsky’s Biosphere Theory and Lovelock’s Gaia Hypothesis**

In my experience, an inevitable question that would follow any of my presentations on Vernadsky’s biosphere theory is: “What is the difference between Vernadsky’s biosphere and Lovelock’s Gaia?” Therefore, I find it necessary to consider this question, but only briefly as it outside of my present study’s main objectives.

James Lovelock<sup>16</sup> introduced his Gaia hypotheses<sup>17</sup> first in 1972 as a one-page note, “Gaia as seen through the atmosphere”, in the journal “Atmospheric Environment” that considered the evidence “mostly drawn from the atmospheric composition of the Earth and its state of disequilibrium” (Lovelock, 1988, p.8). Then, together with biologist Lynn Margulis, they “produced more detailed yet concise statements in the journals ‘Tellus’ and ‘Icarus’” (Ibid.). In 1979, Lovelock published his book *Gaia: a New Look at Life on Earth*, “which collected all [their] ideas up to that point” (Ibid.).

Lovelock’s Gaia hypothesis assumes that Earth is a gigantic organism. In Lovelock’s own words: “The Gaia hypothesis supposes the Earth to be alive, and considers what evidence there is for or against this supposition” (Lovelock, 1988, p. 8).

Some might wonder how the biosphere theory of Vladimir Vernadsky (1926) and the Gaia hypothesis of James Lovelock (1979) relate to each other. An extensive analytical comparison of these two concepts was done in George Levit’s book published in 2001. One chapter of Levit’s book, which is so far the most comprehensive research on Vernadsky’s theoretical legacy, is devoted to the analytical comparison of Vernadsky’s biosphere theory and Lovelock’s Gaia hypothesis.

Although some comparative investigations of James Lovelock’s and Vladimir Vernadsky’s theoretical views were made before Levit, nobody provided such a detailed comparative analysis of their ideas as he did. In Levit’s own words, the main concern of

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<sup>16</sup> “James Ephraim Lovelock, (born 26 July 1919) is an independent scientist, author, researcher, environmentalist, and futurist who lives in Devon, England. He is known for proposing the Gaia hypothesis, in which he postulates that the Earth functions as a kind of superorganism” ([http://en.wikipedia.org/wiki/James\\_Lovelock](http://en.wikipedia.org/wiki/James_Lovelock), retrieved on March 25, 2010).

<sup>17</sup> “The Gaia hypothesis is an ecological hypothesis proposing that the biosphere and the physical components of the Earth (atmosphere, cryosphere, hydrosphere and lithosphere) are closely integrated to form a complex interacting system that maintains the climatic and biogeochemical conditions on Earth in a preferred homeostasis” ([http://en.wikipedia.org/wiki/Gaia\\_hypothesis](http://en.wikipedia.org/wiki/Gaia_hypothesis), retrieved on March 25, 2010).

his study on this matter revolves around the question posed by Jacques Grinevald back in 1996 (p. 47): “What is the difference between Gaia and the biosphere?”

Levit examined “the basic statements of the Gaia theory as represented in the works of Lovelock and other advocates of his theory” and compared “these statements with those of Vernadsky.” He emphasized that in comparing the two theories, he looked “only at the most general basic statements due to incomparability of the scientific data available now and at Vernadsky’s time of writing” (Levit, 2001, p.92).

Levit considered specifically the ideas that “Lovelock himself sees as innovative” (Levit, p. 92). I find it important not to paraphrase but to bring the conclusions of Levit’s comprehensive and detailed analysis of Vernadsky’s and Lovelock’s ideas in his own words (Levit, 2001, p. 14):

The comparative analysis of the Gaia-theory and Vernadsky’s theory of the biosphere shows that some crucial theoretical claims, which are fundamental to the Gaia-theory, had already been stated by Vernadsky as early as in the 1920’s and 40’s. These include: (1) the biogenic character of the biosphere; (2) The self-regulating capacity of the biosphere; (3) the evolution of the biosphere as a whole system including both its biotic and abiotic components. Until the advent of the Gaia-theory theoretical investigation into these problems was continued by the followers of Vernadsky<sup>18</sup>.

Some other important theses of Lovelock’s Gaia-theory, however, have no direct analogies in the Vernadskian tradition. These include: (1) the thesis that Gaia has “vital organs and a core”; (2) the concept of Gaia as a living organism.

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<sup>18</sup> As it was shown in chapter 2, Vernadsky’s innovative ideas on the biosphere were not only articulated in the 1920’s, but by the 1970s when Lovelock had been developing his Gaia hypothesis, they already penetrated intellectual space of science, although often without attribution to Vernadsky. This is exactly why a modern historian of science and the key expert on the biosphere concept evolution Grinevald (1998) termed the significant impact of Vernadsky’s ideas on modern science and scientific paradigm as the *invisible Vernadskian revolution*. Vernadsky’s ideas are not only at the core of the modern science of ecology as they were accepted by the founders of this discipline (e.g. Hutchinson and Odum), but conceptually are embodied in such important fields of knowledge as Earth system science, environmental science, and a new, emerging discipline of sustainability science.

There are two more important observations Levit made. One of them concerns the essence of the biosphere concept. Levit emphasizes that in contrast to James Lovelock (ibid, p. 108-109),

Vernadsky never understood the biosphere as [only] a totality of living organisms or just a domain where life exists or as a living entity. In Vernadsky's theory, the biosphere appears as a "bioinert" self-regulating system and, at the same time, as a geological envelope including both living matter and its inert environment. Bioinert system is defined as a system "which is made by living organisms and inert processes simultaneously and represents the stable dynamic equilibria of both of them".

Another observation is that not all of the Gaia hypothesis advocates share Lovelock's opinion that Earth is a living organism. For example, even his co-author of the Gaia hypothesis, Lynn Margulis says: "I reject Jim's statement 'The Earth is alive'; ...I do not agree with the formulation that says Gaia is an organism'" (Margulis, 1996, p. 54, quoted in Levit, 2001, p. 95). In a co-authored book with Sagan they write (Margulis & Sagan, 2002, p. 130):

One great advance since Vernadsky's recognition of life as geological force has been James Lovelock's Gaia Hypothesis. Lovelock recognizes that Earth's atmospheric chemistry, its mean global temperature, and its ocean's salinity and alkalinity (pH 8.2) of its surface environments are not random. They are regulated, presumably by the metabolism of the sum of Earth life. This sort of global modulation does not mean the Earth surface is equivalent to an organism (which cannot, like the biosphere, survive on its own waste and breathe its own gas excretions.

I had a chance to witness myself at the "Bioneers at the Bay: Connecting for Change" conference (UMASS, Dartmouth, 2006) how Margulis answered the question when somebody in the audience asked whether she really thinks that Earth is a living organism. Her reply was extremely succinct: "None of the organisms can eat its own

shit!” For a moment it was kind of a shock for everybody, but no more questions on this topic followed.

Although it would be very interesting to reflect on the details of Levit’s investigation, this would require substantial time; additionally, this question is outside of the major goals of my present research. But I hope to update Levit’s analysis in the future as more of Lovelock’s publications appeared after Levit’s book was published. To the readers who are interested in more details on this matter, I can strongly recommend reading Levit’s book and, in particular, the chapter comparing Vernadsky’s and Lovelock’s theoretical insights.

However, there is another important reason to compare Vernadsky and Lovelock, the reason that is directly relates to the question of ethics in scholarship and research which is a serious problem in science and education now. These two famous figures provide a sound example of different patterns of behavior in this regard, but this question is outside of the author’s present research objectives and will be considered somewhere else later.

For now, I would like to add that some authors refer to Lovelock’s Gaia hypothesis as a theory, like Levit does in his study (2001). However, one of the principal differences between Vernadsky’s biosphere theory and Lovelock’s Gaia hypothesis is that between theory and hypothesis in general. Jose Wudka (2010, p. 6) defines the difference between theory and hypothesis as following: “to a scientist a theory is a conceptual framework that explains existing observations and predicts new ones” and a “hypothesis is a working assumption” that needed to be tested and be generally accepted to become theory.

Therefore, it seems unjustified from a scientific point of view that Lovelock's Gaia hypothesis could be called a theory until (1) Lovelock's concept of Gaia as a living organism and (2) his thesis that Gaia has vital "organs and core" will be tested and generally accepted. All this, however, does not exclude the metaphorical importance of the Gaia concept which, in one form or another, could be traced far back to primordial times for many cultures, if not to some extent for all.

To summarize, it is necessary to observe that Lovelock's important contributions to science, such as his invention of "the electron capture detector (ECD) – the most sensitive, easily portable and inexpensive analytical device able to detect substances present in the atmosphere at concentrations as low as parts per trillion ( $10^{-12}$ )" (Piqueras, 1998, p. 167) and others, have already become an integral part of modern science as well as the history of science. However, his Gaia hypothesis should not pretend to be the invention that substitutes Vernadsky's theory of the biosphere. It is as simple as the universal rule of "Don't reinvent the wheel". Historically, Lovelock's Gaia hypothesis could be identified at most as one of the attempts to further develop Vernadsky's original theory of the biosphere, based on the advances of modern science made since the time of Vernadsky.

### **Vernadsky's Noosphere**

#### **Noosphere: The Next Stage in the Evolution of the Biosphere**

Vernadsky defined the future evolutionary state of the biosphere as the noosphere, in which human reason will allow for sustainable development (although the latter term did not exist at that time). Noosphere literally means "the envelope of mind" (Smil, 2002,

p. 12) or the “sphere of human thought” (Wikipedia Encyclopedia, 2004). According to Vernadsky, “the Noosphere is the last of many stages in the evolution of the biosphere in geological history” (Vernadsky, 1945, p. 10). Smil observes (2002, p. 266):

Looking far ahead, Vernadsky considered the emergence of the noosphere as a critical evolutionary step needed for preserving and reconstructing the biosphere in the interest of humanity as a single entity... We have already altered the biosphere to such an extent that the only rational way out is to understand as good as possible its intricate functions - and then to make sure that the future changes we inflict on the global environment will remain within tolerable limits.

The term *noosphere* was first coined by French mathematician and philosopher, Edouard Le Roy (1927):

Le Roy, building on Vernadsky’s ideas and on discussions with Teilhard de Chardin [they both attended Vernadsky’s lectures on biogeochemistry at Sorbonne in 1922-1923 and 1924], came up with the term “noosphere”, which he introduced in his lectures at the College de France in 1927... Vernadsky saw the concept as a natural extension of his own ideas predating Le Roy’s choice of the term (Smil, 2002, p. 13).

Le Roy understood the noosphere as a shell of the Earth or a “thinking stratum” including such various components as industry, language, and other forms of rational human activity (Arbatov & Bolshakov, 1987).

Le Roy’s concept was later developed by Teilhard, who considered the noosphere as something external to the biosphere – a movement from biological to psychological and spiritual evolution. This conception of the noosphere was very different from Vernadsky’s. Teilhard built his conception based on his own philosophical writings, not scientific publications, and was completely ignorant of the biogeochemical approach of Vernadsky. Vernadsky developed his concept of the noosphere out of his scientific theory

of the biosphere (that evolved essentially from his biogeochemical works and his work in philosophy of science) and his own philosophical thought (Grinevald, 1998, p. 24-25):

Both Vernadsky and Teilhard were cosmic prophets of globalization. If Teilhard was a “cosmic mystic”, Vernadsky defined himself as a “cosmic realist”... They shared a belief in science and technology as a universal, peaceful and civilizing force... But in *The Biosphere* and in all his work, Vernadsky’s scientific perspective is radically different from that of Teilhard. The divergence is perhaps best expressed as an opposition between the anthropocentric view of life (Teilhardian biosphere) and the biocentric view of the nature’s economy (Vernadskian Biosphere)...

Vernadsky’s conception of the biosphere and the noosphere reveals an ecocentric perspective as it considers the Earth and its elements (living and non-living matter) and subsystems (atmosphere, hydrosphere, and lithosphere) in their continuous dynamic interrelatedness, interconnectedness, and interdependence.

According to Vernadsky, the biosphere became a real geological force that is changing the face of the earth, and the biosphere is changing into the noosphere. The noosphere, in Vernadsky’s interpretation, is a new evolutionary stage of biosphere, when human reason will provide further sustainable development both for humanity and the global environment:

In our century the biosphere has acquired an entirely new meaning; it is being revealed as a planetary phenomenon of cosmic character... In the twentieth century, man, for the first time in the history of earth, knew and embraced the whole biosphere, completed the geographic map of the planet earth, and colonized its whole surface. *Mankind became a single totality in the life on earth...* The noosphere is the last of many stages in the evolution of the biosphere in geological history (Vernadsky, 1945, p. 8).

The common feature of the events listed by Vernadsky in the above excerpt is their global scope; in the same work, he describes more events that either had taken



place, or have been taking place, or (he assumes) will occur in the future at the global scale, which will be considered in more detail below. All these events that Vernadsky described manifest the phenomenon of globalization<sup>19</sup> as we call it today.

### **Vernadsky, a Prophet of Globalization and Sustainability**

Grinevald (1998, p. 24) named Vernadsky a prophet of globalization because he was among a few in his time who were able to see the first signs or indicators of this planetary process which was identified as globalization not long ago. Indeed, as Joe L.P. Lugalla (2005, p. 1) points out,

The concept of “globalization” is not more than twenty years old, but the social, economic, political, and cultural processes that have been associated with globalization have existed for many years. “Globalization” refers to the increasing movement and exchange of capital, commerce, communication, and culture worldwide (Green 2001:2). These social economic processes are a central phenomenon in today’s world.

The fact that globalization was the topic for a Discovery Program University Dialogue at UNH during the 2005-2006 academic year shows the importance of the issue; the UNH website provides a collection of original contributions by UNH authors (including articles by Mimi Becker, Joe Lugalla and even a play by Tom Kelly) who consider diverse and multiple aspects of globalization from different perspectives (Where in the world is UNH?, 2005).

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<sup>19</sup> “**Globalization** (or **globalisation**) describes an ongoing process by which regional economies, societies, and cultures have become integrated through a globe-spanning network of communication and trade. The term is sometimes used to refer specifically to economic globalization: the integration of national economies into the international economy through trade, foreign direct investment, capital flows, migration, and the spread of technology (Bhagwati, 2004). However, globalization is usually recognized as being driven by a combination of economic, technological, sociocultural, political, and biological factors (Croucher, 2004). The term can also refer to the transnational circulation of ideas, languages, or popular culture through acculturation” (Wikipedia Encyclopedia, 2010).

The phenomenon of globalization manifests that all processes on Earth, including social, political, economic, cultural, and ecological changes, are now taking place on a global scale, and more importantly, demonstrate their (although not always obvious) intimate interconnectedness and interdependence. As Ghilarov (1995, p. 198) observed, “Vernadsky’s synthetic view of the biosphere ultimately embraces the geological, biological, and human forces that change and determine the face of the Earth.”

To illustrate humans’ impact as a geological force at a global scale, Vernadsky listed, among others, the following indicators of globalization to put it in modern language (1945, p. 9):

...mineralogical rarity, native iron, is now being produced by the billions of tons. Native aluminum, which never before existed on our planet, is now produced in any quantity. The same is true with regard to countless number of artificial chemical combinations (biogenic cultural minerals) newly created on our planet. The number of such artificial minerals is constantly increasing.

Vernadsky certainly “was aware of the price paid for this progress,” as Smil justly observed (2002, p. 13). In his “The Biosphere and the Noosphere” paper in *American Scientist* (1945, p.9), Vernadsky pointed out:

Chemically, the face of our planet, the biosphere, is being sharply changed by man, consciously, and even more so, unconsciously. The aerial envelope of the land as well as all its natural waters are changed both physically and chemically by man. In the twentieth century, as a result of the growth of human civilization, the seas and the parts of the oceans closest to shore become changed more and more markedly. *Man now must take more and more measures to preserve for future generations the wealth of the sea*<sup>20</sup>...

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<sup>20</sup> Italicized by I.T.

Does not the last phrase sound not only conceptually but also linguistically as a sustainability<sup>21</sup> message? Indeed, Vernadsky believed in the “*reconstruction of the biosphere in the interests of freely thinking humanity as a single totality*. This new stage of the biosphere, which we approach without our noticing it, is the noösphere” (Vernadsky, 1945, p. 9). It is remarkable that the context of Vernadsky’s noosphere notion and, in particular, the phrase Vernadsky himself italicized in the previous quote, resonates directly with the Millennium Development Goals and Targets adopted at the largest gathering of the heads of states at the UN 2002 Johannesburg Millennium development meeting (UN Development Programme, 2003). These goals manifest the collective will of humanity, through their advanced representatives, toward the eradication of poverty and hunger, combat of HIV/AIDS, malaria and other diseases, promotion of human dignity and equality, and achievement of peace and environmental sustainability.

### **Scientific Thought as a Planetary Phenomenon**

It is necessary to point out that Vernadsky was among the first scientists who started to research humans’ impact on the environment in the last decade of the 19<sup>th</sup> century (Yanshina, 1993, p. 165). Observing the environmental degradation due to humanity’s growing technological power and activities, Vernadsky was disappointed with the role people play in their relationship with the rest of the biosphere and saw

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<sup>21</sup> The most widely used definition of sustainability and sustainable development is that of the UN Brundtland Commission (March 20, 1987): “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (UN, 1987, 1987a).

humans' as disharmonizing, if not destructive, force in nature, but by the 1920s he radically changed his mind (Yanshin & Yanshina, 1990, p. 285):

In his earliest articles he wrote that human technological activity represented a process superimposed on and alien to natural processes and hence antinatural. He later came to understand, however, and proved in a number of his works, that the evolutionary advent of the human race and the development of the scientific thinking also represented a natural process like all others in the world around us. *It followed from this that the scientific thinking of humankind must develop in accordance with the laws of nature and not be set against them, and must strive to transform natural conditions for the maximum satisfaction of human material, energy and aesthetic needs.*<sup>22</sup>

Levit (2001, p. 33) indicates that “the concept of scientific thought as a natural planetary phenomenon is the basic concept of Vernadsky’s philosophy of science and is directly or indirectly connected with all parts of his theoretical system,” which Levit proposed to conditionally structure the following way (ibid, p. 16):

- (1) The theory of the biosphere and its transition to noosphere.
- (2) The theory of space-time.
- (3) The general philosophy (theory) of science.

The concept of scientific thought as a natural phenomenon is at the core of Vernadsky’s concept of the biosphere transition into the noosphere, where human relationship with nature will be consciously balanced, as well as all aspects of local and global societal life (social, economic, cultural, etc.).

Levit points out that Vernadsky started to think in this direction at the time he was elaborating a concept of living matter and the biosphere (2001, p. 33-34):

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<sup>22</sup> Italicized by I.T. to emphasize Vernadsky’s “sustainable development” message toward the necessity (1) to balance the relationship between human society and the environment, and (2) to achieve economic, social and cultural sustainability within human society.

In a rough draft of the book about living matter (1916-17), he draws a parallel between the geochemical influence of living matter and the human influence on the geochemistry of Earth (Sytnik et al., 1988, p. 252). Ten years later (1927) in the plan for the unfinished article “On the Border of Science. Space of the Natural Sciences and Space of Philosophy and Mathematics”, Vernadsky (1988, p. 215) made one more step and noted; “Consciousness as a natural force.”

As Levit noted, it was 10 years before Vernadsky used the term “noosphere” and the same year when Le Roy coined the term (1927). As was mentioned before, Le Roy and Teilhard attended Vernadsky’s lectures on biogeochemistry given at the Sorbonne and the Collège de France in 1922-1923 and 1924. Unlike Teilhard who never cited Vernadsky (Grinevald, 1998, p. 25), “Le Roy specifically cited Vernadsky’s work on geochemistry and the biosphere in his work discussing noosphere” (Samson & Pitt, 1999, p. 51). In both his books (1927, 1928), Le Roy points out that they were written under the influence of Vernadsky’s lectures about Earth’s biosphere which Vernadsky taught at the Collège de France and the Sorbonne. Le Roy also admitted that he accepted Vernadsky’s biosphere concept (Yanshina, 1993).

Vernadsky adopted only the term noosphere from Le Roy but filled it with new meaning. Levit (2001, p. 74) describes:

Vernadsky stated that the evolution of the biosphere goes in the direction of self-stabilisation by increasing the biogenic migration of matter... The most important characteristic of the noosphere is that the instrument of its stabilization appears to be human reason, or better to say, scientific reason. Scientific thought is seen as a function of the biosphere or a planetary phenomenon (Vernadsky, 1991).

Vernadsky elaborated his concept about transition of the biosphere to its next phase, the noosphere, in several papers (1944, 1945, 2007) and, most seriously, in his book *Scientific Thought as a Planetary Phenomenon* written in 1936-1938 and published posthumously in Russian (1977, 1988, 1991) and English (1997).

According to Vernadsky (1991, p. 43), “The main geological force creating the noosphere is the growth of scientific knowledge” (quoted in Levit, 2001, p. 33). Levit points out that in Vernadsky’s interpretation, the “biosphere transforms itself into the noosphere with the help of scientific thought and it’s a *natural process*.” Levit summarizes Vernadsky’s vision of the role of scientific thought in the biosphere transition to the noosphere (2001, p. 74):

“The explosion of scientific creativity” in the 20<sup>th</sup> century (Vernadsky, 1991) is interpreted as a lawful phenomenon resulting from the whole course of evolution. On the wave of this explosion, humankind turns into the leading regulative factor in the biosphere. The responsible role makes it incumbent upon human society to undertake the necessary social reforms like the reconciliation and consolidation of humanity, elimination of war and hunger and a process of democratization (Mikulinskij, 1989). One can say that the biosphere transforms itself into the noosphere by means of scientific thought. Science has a planetary or, better, cosmic assignment. It transforms our planet and lifts up to a higher degree of biospheric *organization*. The transition of the biosphere into the noosphere is a lawful process and will take place with an inevitability derived by the laws of nature.

However, it is necessary to understand that what Vernadsky really means by scientific thought is not pure or “sterile” scientific ideas because, in his opinion, those do not exist in nature (ibid, p. 37):

Examining the key concepts of modern science, he comes to the conclusion that the cessation of any creative function of the human mind (art, philosophy, religion) would retard the development of science. He claims that in the historical perspective, we do not know pure science without philosophy. Philosophy penetrates science and will never be replaced by science (Vernadsky, 1988). The latter does not prevent Vernadsky from considering the principle difference between science, philosophy, and religion.

Svirezhev and Svirejva-Hopkins (2008, p. 467) argue that “Vernadsky’s ideas act on the contrary to doomsday scenarios since he views our civilization as a form of a new geological force – scientific thought and therefore it cannot destroy itself.”

### **Vernadsky’s Noosphere: Utopia or Emerging Reality?**

In her 1993 paper, Fidan Yanshina (1993) observes that some authors believe that Vernadsky’s idea about the transition of the biosphere to the noosphere is utopian, and considers the question whether Vernadsky’s noosphere is a utopia or a real prospect. Indeed, to label something as utopian<sup>23</sup> means to see it as unrealistic. Is it so in the case of Vernadsky’s noosphere?

To answer this question, Yanshina organized Vernadsky’s ideas on the noosphere that he articulated in his publications (1944, 1945, 1991, 1997, & 2007) and looked at them through the lenses of historical events and processes that have been taking place globally since Vernadsky’s death in 1945. Here are the features of the biosphere-noosphere transition predicted by Vernadsky and composed by Yanshina in her Russian-language paper (1993), which is also given by Yanshina and Yasnshin in their later, English-language publication (1997, p. 18):

1. Peopling of all the Earth.
2. Abrupt transformation of the means of communication and commerce between different countries.

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<sup>23</sup> “**Utopia** (in English /juˈtoʊpiə/) is a name for an ideal community or society, which is taken from *Of the Best State of a Republic, and of the New Island Utopia*, a book written in 1516 by Sir Thomas More describing a fictional island in the Atlantic Ocean, possessing a seemingly perfect socio-politico-legal system... The term has been used to describe both intentional communities that attempted to create an ideal society, and fictional societies portrayed in literature... The word comes from the Greek: οὐ, "not", and τόπος, "place", indicating that More was utilizing the concept as allegory and did not consider such an ideal place to be realistically possible” (Utopia, 2010).

3. Establishment of political and other ties between all the states of the Earth.
4. Predominance of the geologic role of man over others which take place in the biosphere.
5. Expansion of the frontiers of the biosphere and man's exit into the Cosmos.
6. Industrial exploitation of the new sources of energy.
7. Equality of the people of all races and religions.
8. Increase of the role of people's masses in the decisions on the questions of internal and foreign policy.
9. Freedom of scientific thought and scientific search from the pressure of religious, philosophical, and political considerations, and the creation of the conditions, favorable for free scientific thought, in social and state life.
10. Rise of the well-being of the world's people. Creation of the real possibility to exclude malnutrition, hunger, misery, and to weaken the influence of diseases.
11. Rational transformation of the original nature of the Earth, with the purpose to make it capable of satisfying all material, aesthetic, and spiritual demands of mankind.
12. Exclusion of wars from the life of society.

Even a brief look at this list gives an idea that many events Vernadsky associated with the coming of the noosphere era either already took place, or are still developing, or could be anticipated in the future. Again, as it was noted before, Vernadsky did not provide an exact time-line for the occurrence of certain events listed above, but based on the scientific analysis and synthesis of the knowledge available, he was able to foresee the general direction of the further development of global society and the biosphere on the whole. This fed his confidence that the noosphere is the next, inevitable phase in the evolution of the biosphere, when collective human reason will consciously balance the



nature-society relationship and will resolve economic, social, and cultural societal injustice.

If we look at humanity's collective will expressed in the Millennium Development Goals (UN, 2002) which were briefly mentioned in the previous section and will be considered in more detail in Chapter 4, it is obvious that the general direction of humanity's historical path, although slowly and painfully, certainly moves in the direction ingeniously sketched by Vernadsky.

Pessimists and skeptics who criticize Vernadsky's noosphere as utopian should keep in mind that history already proved many of his predictions made on different occasions. Although these predictions included some intuitive elements, they were based on *the laws of nature* in Vernadsky's words.

For example, an "industrial exploitation of the new sources of energy" – one of the features of the transition to the noosphere foreseen by Vernadsky and listed above. Yanshin and Yanshina describe (1997, p. 10):

V.I. Vernadsky was one of the first scientists who predicted the possibility of controlling the rate of radioactive decay and using radioactive elements as energetic raw materials. As early as in 1910 [i.e. 100 years ago], he held a lecture *Topical problem in the study of radium* at the general meeting of the Academy of Sciences. In 1911, the lecture was published. The lecture contained a comprehensive program of the geological, chemical, and technological investigations directed to the search of the uranium ores and to their study as possible raw materials for the production of power.

Vernadsky initiated these studies in Russia and in 1922 organized the Radium Institute in St.-Petersburg which he directed until 1938. Today it is an active, world-renowned research institution, whose research contributed substantially to the development of the nuclear energy industry in the former Soviet Union and now in Russia.

Or another example: when in 1944 Fascism still was not defeated, Vernadsky was entirely confident in the outcome of World War II, the most bloody war in the history of humanity, and wrote (1944, 1945, p. 8):

The geological evolutionary process shows the biological unity of all men... This is a *law of nature*. In a historical context, for instance, in a war of such magnitude as the present one, he finally wins who follows that law. One cannot oppose impunity the principle of the unity of all men as a law of nature. I use here the phrase 'the law of nature' as this term is used more and more in the physical and chemical sciences, in the sense of an empirical generalization established with precision.

From this position, one could argue that it would rather be Vernadsky who would see as *utopian* many of the global society's deficiencies and inequalities which still persist today. Among them, the rich-poor gap, neo-colonialism, ecological, economic and social injustice manifested by the fact that less than 5% of the world's population consumes more than 25% of the world's resources, and many other indicators. Moreover, even from the common sense perspective it seems really *utopian* to believe that all these practices will continue to prevail in the long run.

Yanshina (1993), after completing her comprehensive analysis of the above 12 prerequisites predicted by Vernadsky for the biosphere transition to the noosphere, concludes that the authors criticizing Vernadsky's noosphere concept as utopian, seemingly did not read Vernadsky's original writings. Indeed, it seems people often choose to rely on the secondary sources which do not always interpret or correctly transmit Vernadsky's ideas. Also, as it was shown above, the conditions listed by Yanshina (1993) are in tune with the United Nations Millennium Goals (2003).

And finally, as P.R. Masani says (1995, quoted in Galactic Research Institute, 2006),

...it is unscientific to accept the concept of a biosphere and to reject the concept of the noosphere. Noosphere is as much a part of earth as any other sphere, such as hydrosphere. Indeed, by virtue of its being the cause of most ecological woes and the seat of all ecological action, the noosphere should, from the ecological standpoint, be the most crucial layer. Its health and its protection from man's own perversity should be one of the concerns. For obviously noospheric pollution is the source of all pollution.

The title of the article that cited the above excerpt is also noteworthy and sounds as a declaration: "It is not a biospheric crisis, but a noospheric emergency – envisioning the regeneration of planet Earth."

### **Vernadsky's Theoretical System and Sustainability Education**

Alexander Yanshin wisely observed (1993): Although his individual scientific achievements are important, the main reason for appreciation of Vernadsky's work is our urgent 'necessity of a complex holistic conceptual approach' to the problems of increasingly and rapidly deteriorating environment and impending global ecological crisis." Indeed, as Ghilarov points out (1995, p.198): "Vernadsky's synthetic view of the biosphere ultimately embraces the geological, biological, and human forces that change and determine the face of the Earth. The most important implication is that these forces are considered deeply interconnected."

Today Vernadsky's theoretical system, his thought and ideas are in great demand. It is obvious that he was much ahead of his time, and now, almost one hundred years after he first articulated the biosphere concept, Vernadsky's time has come. Many contemporary scholars and educators emphasize the importance of integrating Vernadsky's ideas into contemporary education:

- “...the Biosphere should be a central theme of environmental education, which itself could benefit substantially from recognizing and acting on this virtual imperative” (Polunin, 1980, p. 89);
- “Vernadsky’s *La Biosphère* must become a classic, within environmental education as well as scientific learning. We should also credit Vladimir Vernadsky with the title of father of global ecology of the biosphere” (Grinevald, 1996, p. 48);
- “...required reading for all entry level students in earth and planetary sciences” (Schneider, 1998);
- “Vernadsky’s classic [*The Biosphere*, 1998] will be of value for the specialist, students and the public at large” (Varela, 1998);
- “Vernadsky’s perceptual challenge is an educational imperative – how to look at the world from a biospheric perspective” (Thomashow, 2002, p. 111);
- “Today, the general insights of Vernadsky, regarding the life-enhanced interconnectivity of air, soil, and water, need to become the shared visions of everyone” (Volk, 2007, back cover of Vernadsky, 2007);
- “We have reached a point on our planet when serious debate on what to do about global warming can no longer be postponed. An understanding of Vladimir I. Vernadsky’s work on the biosphere and noösphere is absolutely central to such conversations. It is our hope that bringing Vernadsky’s ecological vision to the English-speaking world will help deepen our understanding of planetary processes and enable us to become better stewards of our planet” (Synergetic Press, 2007);

Indeed, to solve global ecological problems that may endanger even the very existence of human civilization in the not very distant future, a cultivation of a new worldview among people, and especially young generations, is absolutely needed. I.P. Volkov (1997) puts it this way:

The methodological rule of the global approach is to rise above the everyday occurrence, run up above the Earth, to become that astronaut who's observed the Earth from the Moon... or to become a spaceman watching (and studying) the planet phenomena from the orbit near our Earth. Though none of the globalists has visited the outer space yet, nevertheless, each of them is able to do it with the help of psyche in his imagination, in his thoughts, in his imaginary view of the planet out of the space. That is the noospheric outlook on the phenomena of the Earth.

In order to reach this result, Vernadsky's biospheric and, even better, noospheric perspective must become the context of all educational activities. A holistic and ecological worldview embodied in Vernadsky's ideas should be cultivated not only through teaching special courses (e.g. in environmental studies, natural resources, Earth system science), but must be integrated into the general education curriculum and all educational activities. Indeed as many authors emphasized above, we reached the point in our co-evolution with the rest of nature when the biospheric perspective has become a requirement of our time and must become a universal educational imperative in order to motivate people on massive scale to switch to a sustainable way of life. This important theme will be considered in Chapter 4.

As important as it is, a scientific component of sustainability education alone is not sufficient for achieving the desired result of raising a generation of *conscious biospherians*. The other element of sustainability education – values and spirituality – is essentially important for the development of an ecological and holistic perspective, which is the theme of the next chapter.

## CHAPTER IV

### VLADIMIR VERNADSKY'S THEORETICAL SYSTEM AS A CONCEPTUAL FRAMEWORK FOR UNIVERSAL SUSTAINABILITY EDUCATION

*The biosphere is as much, or even more, the creation of the Sun as it is a manifestation of Earth-processes. Ancient religious traditions which regarded terrestrial creatures, especially human beings, as 'children of the Sun' were much nearer the truth than those which looked upon them as a mere ephemeral creation.*

Vernadsky, 1926

*In the end we will conserve only what we love. We love only what we understand. We will understand only what we are taught.*

Baba Dioum, 1968

*...the Biosphere should be a central theme of environmental education, which itself could benefit substantially from recognizing and acting on this virtual imperative.*

Polunin, 1980

*Vernadsky's *La Biosphère* must become a classic, within environmental education as well as scientific learning. We should also credit Vladimir Vernadsky with the title of father of global ecology of the biosphere.*

Jacques Grinevald, 1996

*Vernadsky's perceptual challenge is an educational imperative – how to look at the world from a biospheric perspective.*

Mitchell Thomashow, 2002

*The sustainability revolution, which is nothing less than a rethinking and remaking of our role in the natural world. It is a recalibration of human intentions to coincide with the way the biophysical world works. It is slowing down our bodies, convivial association and nature. The concern for our longevity as a species represents a maturing of our kind to consider ourselves first as 'plain members and citizens' of an ecological community, and second as trustees of all that is past with all that is yet to come – a mystic chain of gratitude, obligation, compassion and hope.*

David Orr, 2006

## **United Nations Decade of Education for Sustainable Development**

The specificity of our time is that we are living through an impending global ecological crisis, and if people do not change their attitudes and actions, a global ecological catastrophe is inevitable. And here is the role of sustainability education, which is needed to help people to understand how the society-nature system works and that people have power to maintain this balance. Sustainability education is based on the notion of sustainable development, which was defined by the Brundtland Commission (the United Nations World Commission on Environment and Development) in 1987 as follows: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

In 1991, with the publication “Caring for the Earth: A Strategy for Sustainable Living” by the World Conservation Union (IUCN), the United Nations Environment Programme (UNEP) and the World Wide Fund For Nature (WWF), the Brundtland Commission’s definition of sustainable development was clarified as “improving the quality of human life while living within the carrying capacity of supporting ecosystems.” Thus, the latter definition “emphasizes meeting human needs in a manner that respects intergenerational responsibility”, as well as takes into account the carrying capacity of supporting ecosystems.

In 1992, the UN Conference on Environment and Development in Rio de Janeiro, the Earth Summit, re-affirmed the vital need for sustainable development to ensure our positive future and gave high priority to education in its Agenda 21 as a key prerequisite for realizing it. The Rio Summit turned out to be the largest international environmental conference ever held, with over 30,000 people and more than 100 heads of state

participating. Through the documents adopted (including the Rio Declaration on Environment and Development and Agenda 21), the Earth Summit worked out principles and laid down a plan for achieving sustainable development in the 21<sup>st</sup> century, which in fact expressed the will and commitment of the global community. Along with the importance of eradicating poverty, both the Rio Declaration (27 principles to guide action) and Agenda 21 (a strategic action plan for sustainable development) prioritized protecting the natural environment (<http://www.unesco.org>).

Chapter 36 of Agenda 21 emphasizes the key role of education for “promoting sustainability development and improving capacity of the people to address environment and development issues. Ever since then sustainable development has been a common concern in all UN conferences and there has been a common consensus that education is a driving force for the change needed. It has also been pointed out that peace, health, and democracy are mutually reinforcing prerequisites for sustainable development” (<http://portal.unesco.org>).

In 2002, education as the foundation of sustainable development was reaffirmed at the Johannesburg Summit. Education was recognized as a powerful tool for addressing pressing global issues, such as rural health care, HIV/AIDS, rural development, the environment, community involvement, and human values and human rights. It was also said that there is no universal model of education, and each country must define its own priorities and actions (Tarasova, 2005). The summit proposed the Decade for Education for Sustainable Development (DESD) for the period 2005 – 2014, which was proclaimed by the United Nations General Assembly in December 2002.



“The basic vision of the DESD is a world where everyone has the opportunity to benefit from education and learn the values, behavior and lifestyles required for a sustainable future and for a positive societal transformation” (UNESCO, 2005). The UNESCO document, *United Nations Decade of Education for Sustainable Development (2005-2014): International Implementation Scheme (2005)*, outlined DESD goals, values, principles, and the ways to implement the program. It identified ten key action themes for the DESD:

- Overcoming poverty
- Gender equality
- Health promotion
- Environmental conservation and protection
- Rural transformation: Education for rural people
- Human rights
- Intercultural understanding and peace
- Sustainable production and consumption
- Cultural diversity
- Information and communication technologies

One could not fail to see the striking similarity between Vernadsky’s 12 preconditions of the biosphere transition to the noosphere, discussed in the previous chapter, and the above DESD key action themes.

The UN *International Implementation Scheme* (2005) also identified four major goals of education for sustainable development: improving access to quality basic education, reorienting existing education programs, developing public understanding and awareness of sustainability, and providing training. By stating that “no universal models of ESD exist” and “while there is overall agreement on principles of sustainability and

supporting concepts, there will be nuanced differences according to local contexts, priorities, and approaches”, it gives to educators who are passionate about sustainability education the possibility to enact their creativity through working out effective ways of teaching sustainability. And yet, how could someone achieve the common goal of sustainable development through supposedly a universal sustainability education if the common approach or a common conceptual model for teaching sustainability is still missing?

### **The UN DESD’s Challenge for Educators: The Need for a Common Approach**

Indeed, educators are currently facing a serious and paradoxical situation. On the one hand, students are frustrated by information regarding the impending global ecological crisis and often feel hopeless about their own and their children’s uncertain future; they are not sure and often do not believe that each individual can make a difference and contribute to a positive change. The public is moved but often lacks the knowledge and skills to live sustainably.

On the other hand, teachers, instructors, and educators (including parents and faith community leaders) are not only confused by the overwhelming flow of information on sustainability and sustainable living, but often are lost trying to adapt multiple and various approaches to sustainability education. A common methodological and pedagogical approach to teaching sustainability does not exist.

My recent participation in the annual meeting of the North American Association for Environmental Education (NAAEE) in November 2007, and specifically full-day sessions with the Sustainability Education Commission and the International

Commission, have shown that both academics and practitioners are not unified in their ideas about what exactly sustainability is and how to teach it. As Jamie Cloud, the director of the Cloud Institute for Sustainability Education in New York City, described the situation: “We are teaching something we do not know, and teach it without knowing how to do it” (NAAEE, 2007).

Thus, while practitioners fully understand the importance of sustainability education and are passionate about promoting it, they do not know “what” to teach and “how” to teach it. They are lost and need a conceptual model to become effective. There are multiple approaches to sustainability education, but the common approach to the concept of sustainability as well as the methodology and pedagogy of teaching it are missing.

And here is the enormous challenge for educators at all levels, including parents, faith community leaders, teachers, and instructors. The challenge is that in order to educate others, first of all, the educators themselves must be ecologically literate, and secondly, they need to know clearly *what* to teach and *how* to teach when conveying sustainability education to others. This means that specific programs targeting educators’ sustainability literacy should be developed and implemented at local, global, and national levels. The key point is that they should be conceptually identical, while simultaneously open to initiative, creativity of instructors and students, and be adapted specifically to local particularities.

Indeed, the goals of sustainability could be achieved only in case the whole world would act in tune in terms of sustainability ethics and lifestyles in common at all societal levels: personal, family, community, national, and finally global. Certainly, this does not

appear to be a very near-future perspective, but to approach this state of the world, common principles of educating people and a common conceptual framework and language are needed. But we cannot wait until the common conceptual approach will be elaborated, applied and implemented. The good news is that we can teach sustainability, universally and effectively, right now. *And we have an irreplaceable importance in Vernadsky's theoretical system which already can be used as a universal conceptual framework for teaching sustainability **today**.* This is as simple as the undeniable fact that any hypothetical conceptual model of teaching sustainability will inevitably embody, consciously or unconsciously, the Vernadskian biospheric science and perspective.

The previous chapter clearly shows that Vernadsky's theoretical system could and should, in the author's conviction, be consciously integrated into curricula as a scientific and philosophical basis for sustainability education. Also, the exceptional value of Vernadsky's theory of the biosphere is that while students are introduced to the biospheric perspective, it serves as a conceptual framework for and is a context of any educational activities – irrespective of the discipline or educational settings. This means that to make sustainability education effective, independently of the subject matter taught, the instructor is expected to regularly refer to the biospheric significance of what s/he is teaching, thereby demonstrating to students the inherent interconnectedness and interrelatedness of all issues under consideration, which all without exception are important elements of the biosphere as a whole system.

However, it is necessary to admit that Vernadsky's concept of the biosphere and the noosphere offers much more for education in general and sustainability education in particular than just a modern scientific paradigm and, basically, the synthesis of all

available knowledge with the advances that took place after Vernadsky's time. However, as was pointed out before, knowledge alone is not sufficient to motivate people for sustainable life-styles and actions. People's value system, their worldview, and emotional involvement are key elements determining their choices and decision-making or, in another words, the way they use knowledge.

Uniquely, in addition to the comprehensive and condensed scientific synthesis Vernadsky's theoretical system offers, it simultaneously embodies and manifests an ecological and holistic worldview, which is the key for decision-making and conflict resolution in our time of global crisis. Moreover, Vernadsky's thought and his personality itself addresses other essential dimensions of general educational and pedagogical significance which are especially important for sustainability education, such as values and ethics, spirituality and connection with nature, relationship between science, philosophy, and religion which will be considered in the following sections. Also, someone might wonder how the official educational system in Russia – Vernadsky's motherland – responds to the challenges of sustainable development.

### **Russian Approach to Sustainability Education:**

#### **Cultivating the Noospheric Perspective**

As in the majority of the countries which approved the United Nations documents on sustainable development and welcomed enthusiastically the UNESCO Decade of Education for Sustainable Development, in Russia there is still a lot of rhetoric about the need for universal education for sustainable development. However, as is shown below, it

seems that Russia probably has some objective advantages over the United States in terms of being better prepared for accepting the ideas of sustainable living.

There are several terms that are in use in contemporary Russia, which target similar objectives of environmental preservation, conservation, and balanced development of the society-nature system: ecological education, environmental education, nature/conservation management, *education for sustainable development* (*образование для устойчивого развития*), and *noospheric education* (*ноосферное образование*). The latter two terms are the most often used in reference to sustainable development. In fact, all these approaches embody Vladimir Vernadsky's theory of the biosphere and the noosphere, which defines the noosphere as a new evolutionary stage in the development of the biosphere, when human-nature interaction will be consciously balanced (Vernadsky, 1945). As Lynn Margulis remarked (Margulis et al., 1998), "Just as all educated westerners have heard of Albert Einstein, Gregor Mendel, and Charles Darwin, so all educated Russians know of Vladimir Ivanovich Vernadsky." Therefore, it is natural for Russian educators at all levels to incorporate Vernadsky's noospheric perspective into their teaching in general and in particular into special courses oriented towards the questions of ecological and conservation problems, and sustainable development.

It is interesting that in Russia the national program on ecological education has been in place for awhile. Even back in the 1970s, Ecology was a mandatory subject at Soviet high schools. Beginning in the 1980-1990s, after the political atmosphere in the country changed, Vladimir Vernadsky and his immense contribution to science, philosophy, and his new vision of the world became well known and justly recognized

nationally. Moreover, Vernadsky's teachings about the biosphere and the noosphere (Vernadsky, 1926, 1945, 1998), which in fact are theoretical foundations for sustainable development, were purposely incorporated into a national program of ecological education. Law No.2060-I of the Russian Soviet Federal Socialist Republic on the "Preservation of the Environment" (1991) defined the need for the formation of an overall, integrated, and continuous ecological education, including all stages and levels of pre-school (!), elementary and secondary schools, extracurricular, higher education, and advanced training courses.

Furthermore, beginning in the late 1990s it has become the norm that Vernadsky is cited at the highest governmental levels and his ideas are acknowledged in national environmental policy (Oldfield, 2001; Oldfield & Shaw, 2002, 2006; Yanshin, 2002). For example, both Yanshin (2002) and Oldfield and Shaw (2006) refer to the official document "Concerning the Concept of Russia's Transition to Sustainable Development" that was signed by the Prime-minister Chernomyrdin and approved by President Yeltsin's Decree No. 440 of April 1, 1996, which in its concluding part says: "The progress of the mankind to sustainable development will finally lead to the formation of the sphere of human reason (the noosphere) foreseen by Vernadsky, when the national and individual wealth is measured by spiritual values and knowledge of the man who lives in harmony with the environment" (Ukaz, 1996). Oldfield and Shaw (2006, p. 146) point out that

This reference to Vernadsky and the noosphere has been retained in the subsequent draft State Strategy for Sustainable Development (see Zelenyi mir, 2002) together with affiliated documentation such as that produced for the 2002 World Summit on Sustainable Development in Johannesburg (see Shelekhov, 2002). These documents equate the establishment of the noosphere with a fundamental and qualitative shift in the nature of Russian society from one based on 'economic and material values' to one founded on 'ecological and spiritual–

moral values’.

There are also a number of nongovernmental and nonprofit organizations concerned for example, with conservation issues, social and ecological justice, ethics and philosophy, which use Vernadsky’s thought as a conceptual framework in their activities, both in Russia and across the globe.

In the mid-1990s, a number of government documents regarding a national program on the improvement of the ecological education of the population were approved. For example, within the seven years between 1993 and 1999, investments into *ecological education and enlightenment* in the Russian Federation doubled from 5.2% to 10.0% of the general Federal Ecological Fund expenditures (Report on the Development of the System of Ecological Education in Russian Federation in 1992-2002). The federal law No. 7-Φ3 “On Environmental Conservation” (2002) emphasizes the necessity of the formation of nothing less than an *ecological culture* (chapter XIII) and directs Russian society toward the creation of a national system of overall ecological education. The focus is concerned not just with gaining ecological knowledge and awareness, but with cultivating a new, *ecological personality* and a new, *ecological consciousness* (Lobanova, 2002). In another words, the purposeful goal for all levels of education in Russia is the “formation of a new, noospheric culture”, which embodies a global, ecological, and holistic view of our reality and gives a real hope for sustainable development of Russia in the visible future.

The following list of some organizations and regular, special events (which is far from being complete) gives an idea of how Vernadsky’s ideas are promoted and popularized in today’s Russia: an annual All-Russia Teenage Readings (The Youth



Research Papers' Competition for high school students in Russia), two awards (from the Russian and from the Ukrainian Academies of Sciences) for outstanding achievements in Mineralogy, Geochemistry, and Cosmochemistry, Vernadsky's Nongovernmental Environmental Fund, the Vernadsky Scholarship Alumni Association (VSAA), an honorable Award Medal "For Contribution to Sustainable Development", the Russian Academy of Sciences Committee on the study of the scientific heritage of academician V.I. Vernadsky (<http://www.tstu.ru/win/kultur/nauka/vernad/imen.htm>). In particular, the Non-Governmental Ecological Vernadsky Foundation that was established in 1995 has its own English-language website, including an electronic version of the magazine *The Noosphere*, which provides more information and details on the above matter (NGIVF, 2010).

Furthermore, to understand the distinctiveness of Russia in its own interpretation of both sustainable development, and its approach to *education for sustainable development* (Kasimov et al., 2002; Kasimov et al., 2005; Verbitskaya et al., 2002) and *noospheric education* (Lobanova, 2002; Milutina, 2004; Safroshkin, 2003; Sikorskaya, 2007; Subetto, 2003, 2003a, 2004), it is necessary to understand 19<sup>th</sup>-20<sup>th</sup> century Russian history. This time period in Russian cultural history has been characterized by the emergence and development of a unique and powerful philosophical movement — Russian Cosmism.

### **Vernadsky and the Philosophy of Russian Cosmism**

Vernadsky's theory of the biosphere and noosphere is simultaneously a product of and a great contribution to the Russian Cosmism school that emerged and developed in

the 19<sup>th</sup>-20<sup>th</sup> centuries. Russian Cosmism includes “both theoretic inquiry and empirical research to explore the history and philosophy of the origin, evolution, and future existence of the universe and humankind. Cosmism drew from both Eastern and Western philosophic traditions. The eclectic nature of the movement's "membership" – philosophers, physical scientists, artists, religious thinkers, and poets – insured that it would maintain a rich and varied knowledge base. Their contributions to science, and to what I label the *expansionary* vision, are immense” (Zey, 2000). According to Michael Hagemeister (1997), “‘Russian cosmism’ and ‘Russian cosmic thinking’ are terms indicative to a broad intellectual movement in contemporary Russia which has scarcely been noticed in the West.”

Nikolai Fedorovich Fedorov (1828-1903) is considered the father of the Russian Cosmism. Fedorov developed his “philosophy of common task” in the second half of the 19<sup>th</sup> century, and it was published posthumously (Fedorov, 1906). “In Fedorov’s thinking, everything in the universe from the tiniest grains of matter to the gigantic stars of distant galaxies was alive and had some degree of consciousness” (Lytkin et al., 1995); according to Fedorov, humans have a special role in the Cosmos because they possess the highest level of consciousness, and consequently, they are responsible for their actions.

Fedorov’s original philosophical thought influenced directly or indirectly a number of Russian intellectuals and resulted in what is now known as the Russian Cosmism school. It includes a constellation of remarkable Russian scientists (Dmitry Mendeleev, Konstantin Tsiolkovsky, Alexander Chizhevsky, and Vladimir Vernadsky), philosophers (Vladimir Soloviev, Nikolai Berdiaev, Vasily Rozanov, Sergei Bulgakov, Lev Gumilev, Helena Blavatsky, Peter Ouspensky, Helena Roerich), theologians (Pavel

Florensky), writers (Fyodor Dostoevsky, Leo Tolstoy, Anton Chekhov), poets (Alexander Blok, Ivan Bely), and artists (Mikhail Vrubel, Arkhip Kuindzi, Wassily Kandinsky, Nikolai Roerich, Mikalojus Chiurlionis), and musicians (Alexander Scriabin, Sergey Prokofiev, Igor Stravinsky, Sergei Rachmaninov) – to mention only some of them.

With all their diversity, what was common in their philosophical thought was essentially the realization of the oneness of humans with the Universe, their reflection on the mystery of life, death, and immortality of the human spirit, and a shift from anthropocentric to cosmocentric worldviews and ethics, as well as their confidence that humanity is entering a new stage in our evolution, which predicted explicit awareness of our *active* and *conscious* role in it.

In turn, Russian Cosmism has its roots in Russian folklore and paganism, which were also incorporated to some extent into conventional Christianity, adopted by Russia more than one thousand years ago. In addition, a specific national feature of the Russian people called *sobornost*<sup>24</sup>, which could be identified as a spiritual brotherhood, unity, or togetherness of Russian people, seems also be the foundation of the Philosophy of Russian Cosmism. Therefore, it is not a coincidence that the theory of the biosphere and the noosphere was born in Russia. The scientific, philosophical, and ethical thought of Vernadsky is extremely relevant to our time, and it explains its popularity in Russia today.

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<sup>24</sup> **Sobornost** (Russian: Собо́рность “Spiritual community of many jointly living people”)... is a term coined by the early Slavophiles, Ivan Kireevsky and Aleksey Khomyakov, to underline the need for cooperation between people at the expense of individualism on the basis that the opposing groups focus on what is common between them. Khomyakov believed the West was progressively losing its unity (Wikipedia, 2010, retrieved on March 3, 2010).

Vernadsky's work holds a special place in the school of Russian cosmism as it is based on his own rigorous scientific research and that of many others, which means that his theory stands on the strong foundation of the laws of nature and empirical generalizations. Cosmism of Vernadsky is reflected best of all in his own words: "To understand something scientifically means to place an event in the framework of scientific reality – that is Cosmos" (Vernadsky, 1991). Vernadsky's pioneering scientific and philosophical thought provides us not only with a synthesis of the scientific achievements, but it also integrates social, economic, political, and cultural processes into one model. In other words, this is a great example of systems thinking and an interdisciplinary approach. Therefore, Dennis Meadows, one of the pioneers and established "gurus" of system dynamics, called Vernadsky "one of the earliest geniuses" (personal communication, fall 2005).

The cosmic perspective that is embodied in Vernadsky's theory of the biosphere and noosphere is at the core both of the *noospheric education* that is emerging and gaining strength in contemporary Russia along with the *education for sustainable development* (sponsored by the government). A cosmocentric perspective is optimistic and spiritual in its nature, fostering the highest human feelings and aspirations; it shows our uniqueness, our genuine place and mission in the Universe as cultural creatures, and thereby gives hope for a positive future for the human race and motivates people to act today.

To conclude, I would say that noospheric education and sustainability education are very similar because they both target the same goal — a conscious achievement of a balanced relationship between human society and nature. They in no way conflict or

contradict each other. Nevertheless, noospheric education represents a broader concept of human-nature evolution both in terms of time and space. It is based on a strong philosophical foundation and has a powerful component appealing deeply to our human nature; it encompasses the whole cosmos and assigns an actively conscious and responsible role to humans in the further society-nature evolution. I believe that it is important to include in sustainability education Vladimir Vernadsky's notion of the noosphere, a new evolutionary stage in the development of the biosphere when the human-nature interaction will be consciously balanced, because the noosphere concept embodies an interdisciplinary and systems thinking approach, and an optimistic vision of our future.

### **Importance of Spirituality: Vernadsky and Einstein**

Today, Vladimir Vernadsky is often compared to Albert Einstein: "His name is as inseparably linked with the biosphere as Albert Einstein's name is with relativity" (Kauffmann, 1991). It is remarkable that these two giants of scientific thought of the 20<sup>th</sup> century, Vladimir Vernadsky (1863-1945) and Albert Einstein (1879-1955), lived on Earth simultaneously. Even though scientific contacts were extremely limited under Soviets, Vernadsky was able to meet Einstein once in 1927. They met when Vernadsky stayed in Germany for his research at the same time that there was a week of Russian science in Berlin, in which he participated. Einstein directed a group of German scientists for this event. According to Aksenov (1993, p.161), there is an old photograph from this scientific event, with both of them among the other members of the Russian and German delegations. I wonder – did they have a chance to talk?

In connection with the ongoing (for centuries) debate on science and religion, it is interesting to consider Vernadsky's and Einstein's opinions on the matter as they look to be very similar. It is well known that both of them were great humanitarians, although neither associated themselves with any particular religion and did not attend church. Nevertheless, both Vernadsky and Einstein admitted repeatedly and independently their deep religiosity, without following any particular religion or attending church. It is amazing that they even expressed their attitude in the same words. Einstein: "I am a deeply religious nonbeliever" (Einstein, 1954). Vernadsky: "I consider myself a deeply religious man, but meanwhile I do not need either church or prayer. I do not need words and images... So called religious feeling... is a sum of moral aspirations that could take various forms" (Mochalov, 1988).

The "essence of Vernadsky's religiosity is... emotional experience of unity with living nature, with Cosmos in general, with living nature in particular, sense of cosmic nature of life and mind, and *harmony of the universe*, i.e. what Einstein once called a 'cosmic religious feeling'." As Mochalov (1988) writes,

V. I. Vernadsky considered religion as one of the forms of reality's reflection alongside with science, philosophy and arts. But he had not belonged to any particular religious trend and he had not been a religious believer. His «religiosity» was conventional, it was connected with a deep emotional involvement in the creative process, with a feeling of his unity with the universe, with living matter.

Einstein expressed a similar opinion. My feeling, he wrote, is religious insofar as I am imbued with... consciousness of the insufficiency of the human mind to understand more deeply the *harmony of the Universe* which we try to formulate as "laws of nature" (Einstein, 1952).

What they both understood under *religiosity* was, in fact, an expression of their personal *integrity* (the quality of possessing and steadfastly adhering to high moral principles, Encarta Reference Library, 2003) and *spirituality* (awe for creation and appreciation of beauty, reverence of life and love for nature, sense of belonging to and unity with the universe, search for harmony, wisdom, and truth), intensified by their extraordinary creative imagination and intuition. As a matter of fact, they did not need a religious, i.e. spiritual leader because they thought that genuine spirituality extends far beyond any particular existing religion.

It is remarkable that the predictions of many outstanding thinkers from former and present times about inevitable integration of ancient knowledge that religions possess (through exploration of the reality inwards) with scientific knowledge about reality (obtained in exploration directed outwards) are becoming true. It is a characteristic feature of our time that more and more serious scientists such as Carl Sagan (1934-1996), a remarkable American astronomer, openly state that there could not be a “pure”, material science without a spiritual component: “A religion that stressed the magnificence of the universe as revealed by modern science, might be able to draw forth reserves of reverence and awe hardly tapped by traditional faiths. Sooner or later, such a religion will emerge”. In this connection it is interesting to note that the fastest growing of the top twenty religions in the United States is deism: 700% growth between 1990-2000, according to the American Religious Identification Survey (Kosmin, Mayer, & Keyzar, 2001). Deism is a belief “in the existence of a God or supreme being but denies revealed religion, basing its belief on the light of nature and reason”

([http://www.deism.com/deism\\_defined.htm](http://www.deism.com/deism_defined.htm)). The above words of Vernadsky and Einstein about their religiosity are, in fact, a Deistic interpretation of God.

Both Vernadsky and Einstein, two stars of the first magnitude of 20<sup>th</sup> century civilization, were very concerned about the responsibility of those who possess knowledge. Vernadsky warned (1945, p. 8):

The whole of mankind put together represents an insignificant mass of the planet's matter. Its strength is derived not from its matter, but from its brain. If man understands this, and does not use his brain and his work for self-destruction, an immense future is open before him in the geological history of biosphere.

Back in 1922, Vernadsky pointed out prophetically:

The time is not far off when men will receive into his hands the energy of the atom, a source of power that will enable him to build his life as he chooses. Will man be able to use this power, to turn it to good purposes and not to self-destruction? Has he become mature enough to be able to use the power science is inevitably bound to give him?

Unfortunately, the atomic bombing of Hiroshima and Nagasaki confirmed his worries. It has been almost 60 years to the day since two atomic bombs were dropped on the Japanese cities of Hiroshima and Nagasaki in August 1945. The bombs claimed the lives of about 250,000 people (BBC News World Edition, 2002). Although Einstein was not directly involved in the Manhattan Project (which developed the atomic bomb), in 1939 he signed a letter to President Roosevelt that was drafted by the scientist Leo Szilard and urged for a program to build an atomic bomb (lest Nazi Germany build one first). Reflecting on his role in the development of the atom bomb, Einstein said: "If only I had known, I should have become a watchmaker". At the end of his life, Einstein summarized his feelings about his role in the creation of the atomic bomb: "I made one



great mistake in my life... when I signed the letter to President Roosevelt recommending that atom bombs be made; but there was some justification - the danger that the Germans would make them" (Clark, 1972).

Einstein outlived Vernadsky only by 10 years, but this decade brought much more evidence of the planet's deteriorating environment. "Technological progress is like an axe in the hands of a pathological criminal", Einstein noted once. Did he mean Hiroshima and Nagasaki? Or emerging global ecological problems? Does this not agree with Vernadsky's words that "there is nothing large or small in nature"? Although half a century has passed since then, and we have sufficient evidence for the progressively deteriorating global environment, humanity still does not take the problem seriously enough. As Laurens van der Post argues (1986): "We have already got power enough to destroy the whole of human life; but we have not yet got the moral obligation, the sense of good and bad, to match it and follow it as our instrument of metamorphosis. We have not yet accepted that every act of knowledge, every increase of knowledge, increases our responsibility towards creation."

Both Vernadsky and Einstein were internationalists who fought for justice and peace. As prominent scientists and thinkers, they felt they were responsible for the purposeful usage of scientific and technological progress for the well being of the whole of humanity. Therefore, no wonder if they were alive today, they would probably be vocal advocates and propagandists for ensuring that progress was used to benefit the whole of humanity. It would not be a surprise to see Vernadsky in this role, as his concept of the biosphere and noosphere is already embodied practically (either consciously or unconsciously) into all major eco-ethical approaches of environmental

movements and philosophies. The following words of Einstein also suggest that he would stand with active environmentalists these days:

A human being is a part of a whole, called by us ‘universe’, a part limited in time and space. He experiences himself, his thoughts and feelings as something separated from the rest... a kind of optical delusion of his consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and to affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty.

Both Vernadsky and Einstein would agree that people need to change their worldview and attitude toward their fellow brothers and creatures, as well as the rest of creation, from anthropocentric and limited to a more ecocentric and holistic view; otherwise, impending global ecological catastrophe is inevitable. Humans are proud of their possession of reason – for which *they* call *themselves* a pinnacle of evolution. However, if an outside observer watched our planet for some time, s/he would not see us as creatures of reason. Indeed, human beings destroy their own environment and themselves by behaving like a cancerous tumor in an organism. In this context, Elisabet Sahtouris (1999) suggests “to try to look at ourselves from the point of view of some intelligent species from another star system that can observe us”:

Learning what we are and what we are up to, would they consider us an intelligent form of life? Surely it would strike them as most peculiar that we destroy the environment on which we depend. No intelligent species would knowingly pollute its air, water, and soil to the point of endangering itself. It would hardly cram itself into communities of concrete that sealed the species off from natural processes and made its air unbreathable with its own wastes when there was plenty of space on the planet and ways to avoid creating the pollution.

Are we a pinnacle of evolution then?

Certainly, Vernadsky observed the destructive actions of humanity on a global scale: "...the whole mankind put together represents an insignificant mass of the planet's matter. Its strength is derived not from its matter, but from its brain. If man understands this, and does not use his brain for self-destruction, an immense future is open before him in the geological history of the biosphere" (1945, p. 8). But the way he questioned this (1922): "Will man be able to use this power, to turn it to good purposes and not to self-destruction? Has he become mature enough to be able to use the power science is inevitably bound to give him?", and especially the words *mature enough* assume that he probably conceded that humanity was yet in its "wild age" and time was needed for its maturation because, generally, Vernadsky was optimistic about mankind's future as a part of the cosmic order.

Thus, Vernadsky repeatedly says that "Creatures of the Earth are the fruit of a complicated cosmic process and are a necessary and lawful part of a harmonious cosmic mechanism, in which is known chance does not exist" (Vernadsky, 1994, quoted in Levit, p. 73). As Levit points out (2002), the "idea of the cosmic nature of life is connected with all important parts of Vernadsky's theoretical system" (p. 74). Remember Vernadsky's words about scientific reality: "To understand something scientifically means to place an event in the framework of scientific reality – that is Cosmos" (Vernadsky, 1991)?

Both Vernadsky and Einstein, being hard-core scientists and theorists, at the same time were highly spiritual people in terms of their highest values and aspirations. Vernadsky had sympathy for religious thinkers and "mysticism, which he, like Einstein, regarded as a valid source of scientific intuition" (Kauffman, 1991, p. 322). Being

rational Western scientists, they both showed respect for Eastern philosophy. For example, according to Bailes (1990, p. 183), in his famous lectures of 1902,

[Vernadsky] noted that the idea of the interconnectedness of all nature is found in ancient religions and philosophies (a fact familiar to him from his own extensive reading in religion and philosophy and from discussions with his close friend from university days, Sergei Oldenburg, who became a noted Orientalist and specialist in Hindu civilization in the Academy of Sciences). But this idea could remain in science, he argued, only if it is survived the test of scientific method and was given a scientific formulation in laws that could be verified.

As history has shown, Vernadsky himself was destined to accomplish this scientific task by having his biosphere theory, with other parts of his theoretical system, created. Again, it seems that it is not a coincidence that this type of synthesis that includes Eastern philosophy and Western science took place in Russia which geographically, as well as both historically and culturally, has always been at the crossroads between East and West.

The predictions of many remarkable thinkers from former and present times about the inevitable integration of ancient knowledge that religions possess (through exploration of the reality inwards) with scientific knowledge about reality (obtained in exploration directed outwards) are becoming true. Back in 1949, Albert Einstein (1999) recognized that

You will hardly find one among the profounder sort of scientific minds without a peculiar religious feeling of his own. But it is different from the religion of the naive man. For the latter God is a being from whose care one hopes to benefit and whose punishment one fears; a sublimation of a feeling similar to that of a child for its father, a being to whom one stands to some extent in a personal relation, however deeply it may be tinged with awe. But the scientist is possessed by the sense of universal causation. The future, to him, is every whit as necessary and determined as the past. There is nothing divine about morality, it is a purely human affair. His religious feeling takes the form of a rapturous amazement at the harmony of natural law, which reveals an intelligence of such superiority

that, compared with it, all the systematic thinking and acting of human beings is an utterly insignificant reflection. This feeling is the guiding principle of his life and work, in so far as he succeeds in keeping himself from the shackles of selfish desire. It is beyond question closely akin to that which has possessed the religious geniuses of all ages.

Einstein acknowledged the deepness, profundity, and wisdom of ancient religions: “When I read the Bhagavad-Gita I ask myself how God created the universe. Everything else appears to be superfluous”.

It is a characteristic feature of our time that more and more serious scientists like Carl Sagan, for example, openly state that there could not be a “pure”, emasculated science without a spiritual component: “A religion that stressed the magnificence of the universe as revealed by modern science, might be able to draw forth reserves of reverence and awe hardly tapped by traditional faiths. Sooner or later, such a religion will emerge”. In this connection it is interesting to note that the fastest growing religion in the world is deism (700% growth during 1990-2000, according to ARIS). Deism is a belief “in the existence of a God or supreme being but denies revealed religion, basing his belief on the light of nature and reason” ([http://www.deism.com/deism\\_defined.htm](http://www.deism.com/deism_defined.htm)). The following words of Einstein also give, in fact, a Deistic interpretation of God: “My religion consists of a humble admiration of the illimitable superior spirit who reveals himself in the slight details we are able to perceive with our frail and feeble minds. That deeply emotional conviction of the presence of a superior reasoning power, which is revealed in the incomprehensible universe, forms my idea of God.” I would like to conclude with the quote from Albert Einstein that well reflects the ongoing process of approaching science and religion: “I do not think that it is necessarily the case that science and religion are natural opposites. In fact, I think that there is a very close connection between the two. Further, I think that science without religion is lame and,

conversely, that religion without science is blind. Both are important and should work hand-in-hand. It seems to me that whoever doesn't wonder about the truth in religion and in science might as well be dead.”

### **Science and Religion: The Time for Their Reunion**

It seems that the time for the reunion of science and religion has come, because only with the united efforts of both we can slow down the developing global ecological crisis, switch to sustainable development, and balance our relations with nature. Indeed, science and religion are two disciplines that seek truth and attempt to understand the construction of this world, even though they focus on different aspects of the same reality and use different methods to explore and interpret it. While science equips us with the “objective” and practical knowledge about the physical world using the scientific method, religion and various faith traditions, using prayer, contemplation, meditation, and enlightenment, help us gain a value-laden knowledge of our internal and spiritual life and ethical codes that are needed by everyone to find the meaning of life and to value ourselves, other people, and the world in general.

Historical relationship between science and religion has varied dramatically – from full harmony, respect, and mutual understanding to alienation, separation, divorce, and animosity. Ken Wilber (1993, p. 27) found a witty way to describe the latter:

This 2500-year war had been almost as if man were given two pictures of his body – one taken from the front, and the other taken from the back. In trying to decide which of these views was “really real”, man divided into two camps; the “Frontists”, who firmly believed that only the picture taken from the front was real; and the “Backists”, who steadfastly insisted just the opposite. The problem was a tricky one, for each camp had to devise a theory to explain the existence of the other, and so the Frontists had just as much trouble explaining the existence

of the back as Backists had in explaining the existence of the front. To avoid the contradiction, the Frontists spent their time running away from their backs, and the Backists were just as ingenious in devising ways to run away from their fronts. Occasionally the two would cross paths, yell obscenities at one another, and this was called philosophy.

Wilber adds that “so just as front and back are simply two different ways of viewing one body, so subject and object, psyche and soma, energy and matter are but two ways of approaching one reality” (ibid, p. 28). It seems that this understanding is coming.

Indeed, it is an undeniable reality that we face an impending global ecological crisis that threatens the future of our human civilization and culture. In response, science and religion seem to be converging toward a common goal of preventing the global catastrophe. The predictions of former and current thinkers about the reunion of science and religion appear to be coming true. For example, the philosophy of Russian Cosmism looked forward to a time when all of humanity would be united by “the philosophy of common task.” Indeed, is it not the main mission of both science and religion now to collaborate in promoting ecological awareness and cultivating sustainable ways of life in order to ensure a decent life for generations to come?

If only several years ago we talked about the greening of faith (Carroll, Brockelman & Westfall, 1997), now there is enough evidence that science and religion convene toward a common goal of preventing a global catastrophe and switching toward sustainability. The Yale University Religion and Ecology website provides information on the meetings that took place from 1999 until 2009. The statistics is impressive: there was a permanent growth in the number of meetings at the intersection of religion/ethics and ecology/environment from 8 in 1999 to 54 in 2008 and 59 in 2009 worldwide.

I, myself, represent evidence about converging process of science and religion. Someone, knowing me as a scientist, would wonder why I started to participate in religious and theological meetings a few years ago. Indeed, I am a research biologist who is back at school (UNH) to specifically become an effective sustainability educator. My previous professional field is experimental Aquatic Ecology and my present PhD research is in Natural Resources and Environmental Studies. But if someone looked at the dynamics of my presentations at the professional conferences since the time I am back at school at UNH in 2004 (Table 3), s/he cannot help but notice that beginning in 2008, in addition to the meetings on sustainability education, I started to participate in the interdisciplinary, religion and humanities combined meetings that relate to a greater or lesser extent to ecology and/or sustainability.

The answer is straightforward and simple: I consider each meeting at the intersection of ecology and religion (including other humanities) as an opportunity to convey a scientifically informed message about the necessity to cultivate an ecological and holistic worldview and to promote sustainable living. Indeed, from a Systems Thinking point of view (Meadows, 1998), religion and other spiritual traditions represent a great leverage for a societal change because this is exactly where people's value system is shaped and this is an environment which is ready to get a value-laden message. According to Donella Meadows (1999, 2008), values and priorities belong to the highest leverage points in a society. In another words, if people will be able to perceive a biospheric perspective, i.e. ecological and holistic worldview, their value system and priorities will inevitably change towards sustainability.



Table 3

*Irina Trubetskova's presentations at professional conferences related to sustainability education and religion during 2004-2010.*

Year	Sustainability education-related meetings	Religion-related meetings
2004	Northeast Campus Sustainability Summit featuring BIONEERS Satellite Telecast, UNH (Durham, NH)	
2007	North American Association for Environmental Education (NAAEE) Annual Conference (Virginia Beach, VA)	
2008	Second biennial conference of the Association for the Advancement of Sustainability in Higher Education (AASHE) "Working Together for Sustainability – On Campus and Beyond" (Raleigh, NC)	First International Interdisciplinary Conference "Ecological Theology and Environmental Ethics", Orthodox Academy of Crete (Crete, Greece)
2009	New England Educational Research Organization (NEERO) Annual Conference (Portsmouth, NH)	Second International Conference of the European Forum for the Study of Religion and the Environment "Religion & Ecology in the Public Sphere" (Turku, Finland).  A Global Forum – The 2009 Parliament of the Worlds' Religions: "Make a World of Difference: Hearing Each Other, Healing the Earth" (Melbourne, Australia)
2010	Intending to participate (a question of funding) in the third AASHE conference, October 10-12, 2010 (Denver, CO)	NH United Church of Christ annual conference, February 20, 2010 (Pembroke, NH)

Since my first meeting at the intersection of ecology and theology in June 2008 in Greece, i.e. the First International Interdisciplinary Conference "Ecological Theology and

Environmental Ethics,” substantial changes took place. In Greece, for example, theologians and religious leaders were attentively listening to only a few scientists, like me, and had general and mostly just value-laden presentations appealing to our responsibility as stewards of the creation. One year later, in May 2009 in Finland, at the “Religion & Ecology in the Public Sphere” the situation changed a little bit and the same theologians and religious leaders started to use ecological language. And finally, my participation in December 2009 in the Parliament of the World’s Religions (PWR-2009) in Melbourne showed that situation changed dramatically.

First of all the title of the PWR-2009, this unique world forum that gathered 8,000 people, reflected the theme: “Make a World of Difference: Hearing each other, Healing the earth.” It turned out with a pleasant surprise that the same people that I met at my first meeting in Greece only two and a half years ago now easily used ecological language and were well-informed in terms of the most recent scientific data presentations. But the most impressive observation was that not only all plenary sessions, but numerous presentations and workshops I attended contained the same three messages: that we all, independently of our faith and other diversities, share (1) the same common, universal values, (2) the same common home – the Earth, and (3) the same common goal to balance our relations within our human community and with the rest of the creation. It was not surprising that my presentation on the relationship between science and religion (in terms of spirituality) and their reunion taking place in our time also embodied the same messages, although brought from a different perspective.

This unanimity was amazing and extremely inspiring in contrast to the Copenhagen climate change conference 2009 that was literally taking place in the same

time as the PWR-2009. This fact shows that religion and faith communities' leaders are ahead of politicians in terms of their understanding the seriousness of global ecological crisis and its threats, and thereby demonstrate a higher level of professional and personal responsibility. Also, this emphasizes the importance and need for universal ecological and sustainability education in order that all people, irrespective of their professional specialization, including politics, will be scientifically literate enough to take appropriate decisions and act properly.

As it was shown above on the example of Vernadsky and Einstein, genuine science is always spiritual because people either are coming/ to science (i.e. become scientists) because of their spirituality<sup>25</sup> or becoming spiritual through their research and scholarly work which inevitably will lead them to discover out the beauty and miracle of life and the wonder of the universe.

In our technological age, many people are missing these values. It was always the job of world religions to maintain and cultivate the traditional values in their societies. They were and continue to be the only domains where our values are openly discussed, questioned, and often formed. However, in the light of the developing ecological crisis, it is not sufficient to promote humanity's traditional values, because the impending ecological crisis is in fact a spiritual crisis, i.e., the result of the lack of spiritual values in contemporary human society.

Faith communities, along with schools and parents, are called to play an extremely important role in cultivating spiritual values. As a matter of fact, many congregations are already involved in this process. For example, in the fall 2006,

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<sup>25</sup> Spirituality manifests itself through the highest values and aspirations of people, such as love for nature; awe for creation; a sense of wonder, beauty, and mystery of life; oneness with all of life and unity with creation, desire commitment to common good, etc.

thousands of faith communities and Christian denominations throughout the United States showed Al Gore's movie "An Inconvenient Truth" (2006). This allowed hundreds of people to become aware of global warming, our role in it, and what can be done about it. That was also an event of great spiritual value as many people realized that they are part the Earth system and we all are in the "same boat."

Just this single example shows how powerful and effective the faith communities could be in promoting ecological awareness and a sustainable way of life because the people involved are already open to a value-laden message. And here is an exceptional role of religion and religious leaders in our time. Faith community leaders are doing irreplaceable and invaluable work for all of humanity and the common good, by helping their congregations to become aware of what is going on both on a local and a planetary level, and by making connections between *traditional values* (which are embodied in all kinds of religions and in fact universal), and the highest, *spiritual values*.

Although many educational institutions are involved in promoting environmental awareness and sustainability, the spiritual and moral component of an ecocentric approach is often missing "inappropriate"(i.e. undemocratic) to discuss moral and spiritual values in an academic setting. Indeed, as soon as educators decide to teach morality, they face serious difficulties posed by the questions like, "Whose values are [you] going to teach? Are you going to teach religion?" (Kelly, 2004).

And nevertheless, it is possible that scientists and educators can provide people with the needed ecological perspective that includes not only scientific knowledge about how our planet works, but also traditional and spiritual values that are essentially at the core of an ecocentric worldview. For example, Vernadsky gave dozens of lectures for the

public (even during the Russian Revolution and the Civil War) and published his articles “written for popular consumption” in the popular newspapers (Guegamian, 2006); and his scientific messages were always also spiritual because of his “cosmic reality” philosophy and ecological and holistic worldview.

And here is an example of the power of Vernadsky’s thought both in terms of science and spirituality. Even before my presentation on Vernadsky and his ideas in the fall of 2007 IA501 Global Issues in International Affairs class, one of my students (whose dual major is business and international affairs), after reading Vernadsky’s “The Biosphere and the Noosphere” (1945), wrote in her weekly journal (personal communication):

What seemed to me to be a core piece of information in my reading about the Biosphere is that all living creatures in the Biosphere can not live independent of it. The modern way of life in industrialized countries allows humans to feel somewhat disconnected from the biosphere...

I think there should be more general education for all people about the power of human thought and the effect we have on the Earth. I do think this is beginning to happen more with the youngest generations; unfortunately we had to make big mistakes before we could learn from them. Also, if religions accept humans as a geological force then those religions could play a large role in calling for change for ethical reasons.

There are also many modern scientists, like Jim Hansen and numerous scholars at UNH, who are spreading scientific knowledge which is simultaneously spiritually-laden thought outreach to professionals, students, the public, and various communities, and their examples are inspiring and make a difference. The common ground for both science and religion and the major reason for their reunion is the need to help people gain a biospheric perception which is both scientific and spiritual. It is really the time for

religion to become scientific and for scientists to not only leave their “ivory towers” but to openly demonstrate their inherent spirituality.

### **Urbanization: The Importance of Re-connection with Nature**

It was shown above that, as crucially important as it is, the knowledge alone (about the surrounding world and our place in it) is not sufficient to motivate people for proper decisions and practical actions toward sustainability. Another important element of sustainability education is spirituality or an emotional bond with other humans as well as with the rest of creation, and connection with nature plays a key role in this. James Swan (1995) who conducted a 20-year psychological research on “what made people in general care deeply about the natural world”, observed:

Our growing intellectual familiarity with ecology alone is not sufficient motivation to establish an ecological conscience... Without primary emotional roots with nature, ecology tends to be just one more topic that a socially responsible person should be familiar with, rather than a guiding force in one's entire life.

However, many people, especially in the developed countries, are lacking intimate connection with nature due to their “civilized” way of life and unprecedented urbanization of the society. Indeed, at the present time half of the global population lives in cities. According to the U.N. prognosis, the world's urban population will rise from 3 billion in 2003 to 5 billion by 2030; the rural population will decline during that time, from 3.3 billion to 3.2 billion; all of the population increase to come thus will take place, or end up, in urban areas (United Nations, 2004). Therefore, it is inevitable that many people lack contact with nature. Meanwhile, our connection with and respect for nature,

or absence of it, is extremely important because it determines our standpoints toward the rest of the biosphere, including living and non-living nature.

As it was mentioned earlier, there are two main positions in relation to nature: *anthropocentric* and *ecocentric*. It is a matter of fact that an *anthropocentric* approach is embodied in our culture. Judeo-Christian culture was formed on the notion that a human is “the pinnacle of the creation” (The story of creation, Genesis 1: 26-28). This idea was later indirectly “supported” scientifically by the Darwinian theory of evolution. This traditional, human-centered philosophical view that everything in Creation has just instrumental value for humans, who act as a controlling power, authority over nature, is called *anthropocentrism*. Humans are considered here as the universe’s most important entity and treated as preeminent, while other creatures are regarded as subordinate under the domination of humans. Environmental anthropocentrism is the view that all environmental responsibility comes exclusively from human interests. And below is a striking example of a typical, anthropocentric worldview provided by a B.S in electrical engineering from Tufts University in Medford, MA, who has recently graduated from the Dartmouth College – it deserves an extensive citation (Halbrooks, 2002):

The most fundamental characteristic of humans is that we employ purposive action in order to obtain desired ends. The individual subjectively defines these ends, and he always acts rationally in that he believes the means he employs will best satisfy his ends... Since humans are the only beings capable of purposive Action, all material value is completely dependent on us. While all objects possess intrinsic physical properties, none possess intrinsic value. For this reason, it is absurd to advocate the conservation of natural resources as an end in itself... Trees, oil, and animals only have value with regard to how they satisfy human wants, so the market process is the only means by which their true value can be utilized by individuals. If these are truly valued, then as their stock decreases, their prices will climb until they only satisfy the most urgent wants... It is not shortsighted to say that we need only be concerned with the desires of living human beings; living human beings are the sole source of all value in the

known universe. If existing humans wish to burn fuel, cut trees, and kill animals, then that is exactly what they should do.

Typically, humans do wish to save for their own future and for their children's future, but the question of what to save is a value judgment that everyone must decide upon in the present. Saving cannot be done because nature is "intrinsically" valuable or solely for "the future"; nature possesses no value from these sources. Indeed, if there were no human beings on Earth (or anywhere that it would affect them), and the planet blew up, it would be of no concern.

The above lengthy quote is an extreme example of anthropocentric perspective, and, simultaneously, a sound manifestation that education alone, without emotional bonding with nature, might result in a false, deformed vision of the world, a kind of blindness to see and a disability to feel that everything in this world is interrelated, interconnected, and interdependent. For those who have connection with nature, it is unquestionable that we are part of life and that nature has value in itself, i.e. intrinsic value. We are dependent on nature, but nature exists independently of us, and the fact of its existence, the right to exist, proves its intrinsic value. Therefore, we cannot subjectively assign intrinsic value to nature - we can only recognize that it exists. Indeed, nature existed before us, and we have a reason to believe that nature will continue to evolve even without the presence of humans on the face of Earth. It is *ecocentric* perspective that recognizes the intrinsic value of nature, and considers that "the well-being and flourishing of the living Earth and its many organic/inorganic parts have value in themselves (synonyms: intrinsic value, inherent value). These values are independent of the usefulness of the nonhuman world for human purposes" (Rowe, 1996).

But "what factors would move people to value, even love, nature?" – James Swan wonders in his solid psychological research on one of the most difficult conceptual questions of the environmental education – relationship between knowledge and concern (Swan, 1995). In other words, he questions whether ecological awareness is sufficient for



taking practical actions, i.e. changing attitudes, habits, and behavior, and “what [makes] people in general care deeply about natural world?” The answer is that usually knowledge alone is not sufficient to be really concerned and taking care about ecological problems; what really makes people motivated and committed environmentalists is their deep emotional connection with nature. “Positive early life experiences in natural settings” are of crucial importance for formation of passionate feelings toward the natural world, which means “to have a deep reverence for nature and [take] delight in natural beauty”. His conclusion was:

One can develop emotional feelings for nature and environmental quality in later life without strong, positive early life experiences in natural settings, but their absence is certainly a handicap to achieving nature kinship, and perhaps emotional health in general.

Although Swan provides “five major paths to achieving nature kinship and becoming committed environmentalists as adults (intellectual knowledge, social justice, threats to health, health and fitness, and transcendental experiences)”, his main message is about the importance of forming connection with nature in childhood.

When I started to think about myself, I found that I always had this connection and love for nature from the earliest times I can remember, despite the fact that I grew up as a typical city girl: (we used to live in the cities with population from 550,000 to 1,718,000 people). What I am most grateful to my parents and grandparents for is that they exposed me to nature enough; through their infectious example and true values, our vacations and outdoor trips on weekends, exploration of city parks, visiting aquariums, zoological and botanical gardens, gardening and taking care of pets and indoor plants, I had practical opportunity to learn and acquired my love and appreciation of nature. Based

on these experiences, in my turn, I passed my passion for nature to my children who were also raised in urban areas. Thus, my own example represents a useful experience of how to develop an intimate connection with nature in children that inhabit an urban environment.

My connection with nature was always so natural for me, that before taking the NR884 Sustainable Living course at UNH in the fall of 2005, I never realized that some people could lack it. While in this class, I found that always in my daily life I had kinship and respect for nature and used to practice it intuitively all the time when I am out, beginning from my early childhood. I discovered that I have no difficulties for the connection to place through nature at all. No matter whether in the town, city, or exposed to wilderness, I always unconsciously and automatically establish practically instant contact with the natural world; no matter what season, weather, or time of the day, I always unconsciously observe and enjoy signs of the permanently changing nature. It turned out that all my senses (vision, hearing, touch, smell, and sometimes taste) are engaged.

For example when I leave home, I exhale fully – simultaneously with the closing the door – and enjoy to breathe in fresh air, feeling its warmth or coolness, dryness or moistness, its scent and energy; this is like jumping into a new environment. When I am walking through any place, I observe and enjoy overall view – I feel as I am a part of a big picture. Simultaneously, I notice a lot of things around – all signs of the season, colors, and noises – everything blends into a single, harmonic vibration. No matter how busy and rushed I am, I never hesitate to stop to smell the opening buds, blooming flowers, and fallen leaves; or to touch leaves, bark or stones to explore their texture,

structure, and patterns; or to grab a pine cone, acorn, or chestnut to learn their odor. Sometimes on my way, I could pick an edible berry or young needles to chew on them and explore their tart taste. All these pleasures and discoveries are available for everyone at any place, including urban areas, not to mention specific recreational areas (e.g. national parks and reserves), and genuine wilderness. The latter settings are where you can really deeply submerge into elements of nature and easily gain the sense of being part of the web of life.

I found it interesting that the NR884 readings and all class work called for memories, impressions, and experiences from my early childhood, when I, a typical city girl, was able to find the beauty and wonder of nature in little things. Here are the roots of my connection with nature, which is so important for me and which is so natural for me. I remember myself at the age of five or six forgetting myself and time, when observing for simple aquatic life in a small pond in a suburban area of a large industrial city; or day after day watching the process of blossoming of the buds of the stunted poppies on a wasteland in spring time that seemed to me the most beautiful and wonderful flowers in the world. These places were literally my secret spots for unconsciously meditating on wilderness.

I think almost everyone must have similar memories and emotional experiences of first-hand face-to-face contacts with wilderness from their early years. Independently of the place they grew up, either in a big city, or in a country, they all had their special secret places for connection with nature. For some children, even in urban areas, their connection to nature could be their single indoor plant giving life to a beautiful flower. For others it was their single fish in a jar or even a tank with abundant life. Some could

observe butterflies, spiders, earthworms or birds right in a city. Another cared for their beloved pets like a puppy, kitten, rabbit, hamster or guinea pig. Country kids, of course, had better opportunities to be face-to-face with nature. But in most cases, all of them had their secret (and sacred) spots for exercising the sense of wonder and oneness with the natural world in their own and unique way.

Sometimes children in the city, however, have some advantages over their rural peers in relation to the opportunities to experience at once vast and diverse contact with the natural world. For example, large cities often have well-organized zoos and/or aquariums. I remember going, at the age of ten or twelve, with my younger sister and a group of friends from the same neighborhood to the zoo very often. That was one of the best zoological parks in Europe, with a variety of animals, a great museum, and good care for animals. During summer holidays, we would go all the time. In addition to some paid visits to the zoo, we also often secretly (and illegally) entered the zoo through the hole in the fence that went all around the zoo (one boy from our company found the hole hidden in the dense bushes of the city park surrounding the zoo). We enjoyed these visits so much that sometimes we did it day after day, and were never bored. Each visit was like a special ritual we unanimously followed. We always started from the museum that was sometimes really boring due to the dead life, such as displays preserved in alcohol, stuffed animals and birds, posters, schemes, and diagrams. I do not know why (we never discussed this), but it was like a mandatory part of our tours. Therefore, we did it sometimes very fast, and then the real joy started: amphibians and reptiles, birds, hoofed animals, rodents, primates, large mammals (bears, hippopotamus, giraffes, elephants),

predators (wolves, lions, tigers and so on), and the aquatic world. We knew many of them by sight.

Although we were aware that to feed animals was strictly prohibited, we managed to give some of them a little bit of their natural food. For example, we treated some goats and antelopes with fresh grass that we pulled out from the lawns in the zoo because they were usually fed with straw or hay. Or closer to the fall, we picked acorns and brought them in our pockets to wild boars. We felt very happy and satisfied when they ate these gifts. Of course, we knew from our parents that any sweet stuff like candies, cookies, or ice-cream could bring health problems to wild animals (e.g. spoil their teeth, etc.). So, we never did it and were very angry with the kids who tried to do this. We loved all these animals and were very compassionate about them as we sensed what it meant for them to be in captivity. Since we had a lot of freedom, we went there so often just out of solidarity – to visit and to support our fellow brothers. In fact, during these regular excursions we practiced a combination of walking meditation and secret spot (as many times as we stopped to observe different animals).

When I was 13 or 14, I experienced another example of meeting wilderness in the city. My parents recommended to me a book about famous microbiologists from our home library. “A very captivating book,” they said. I read the first essay about Anton van Leeuwenhoek (1632-1723) – the Dutch man, who just through practicing his hobby – polishing lenses - managed to make powerful magnifying lenses that enabled him to be the first person in the history of science and mankind who observed and discovered the amazing world of microorganisms. This aroused my interest to see the micro world so much that I did not give a minute of peace to my parents until they found and brought

home a microscope for me. I continued reading the book – my journey through the greatest discoveries in microbiology since the time of Leeuwenhoek, and I spent hours and hours observing through the microscope fantastic and abundant worlds from the samples I took from outside or prepared at home. During these prolonged and spontaneous meditations, I was fully immersed in another world, being face-to-face with thousands of variable organisms and feeling my oneness with this amazing micro-universe.

Also, I will never forget our regular weekend trips outside, sleeping in a tent and cooking on a campfire, walking through the wood, fishing, picking berries and mushrooms. During summer vacations, our horizons (I had a brother and sister) expanded tremendously: from the Sea of Azov and the Black Sea to Crimea and the Caucasus. Through snorkeling and hiking, we learned about the amazing underwater world, the magical night sky with enormously big and bright stars in the mountains, sparkling glaciers, delightful alpine meadows, and rapid crystal-clear streams. And fairy tales... my parents and my oldest brother used to tell my sister and me stories and fairy tales before we went to sleep.

It is really amazing that although I was born and grew up in a large industrial city, I had so many opportunities to be face-to-face with nature in my childhood. This is because my parents and grandparents valued wilderness and considered the contact with nature as an important and necessary part of human life. This attitude toward nature was very creative, interactive, and mutually enriching in contrast to the position of some people, who considered their relations with nature in a very consumerist self-centered way by trying to get something from it (e.g. health, recreation, material things) without

paying back. As I realize it now, in my family there was always very deep relationship and two-way communication toward nature on both physical and a very deep spiritual level, without sentimental words and behavior, though. It was like a flow of feelings that you radiated outside, and they were returning, purified and enriched by nature, into your soul. Being in this position means that you pay back generously with your love, gratitude, and grace – all of which blend in what is called a sense of wonder, awe for creation, and reverence for life.

No wonder that my later vivid interest and professional choice of becoming a research scientist in the field of experimental aquatic ecology was determined by the sense of wonder I experienced through the above, spontaneous meditations. I believe that it is essentially this sense of wonder that led me later into my profession of a research biologist and later in life to the decision of changing my professional field to environmental education. I still did not lose it. It drives me through all difficulties, obstacles, and hardships in my life.

What was common for all these different emotional experiences is that we felt really like home while being in contact with wilderness and nature wherever it happened. That was a feeling of being really at home because “nature is not a place to visit, it is *home*” (Snyder, 1990). The complete feeling of peace, harmony, and wholeness filled our souls. All these experiences simply show that even in our time when most people are concentrated in urban areas, there are always opportunities to meet, become familiar, and communicate with nature or wilderness.

What are then the concrete ways to develop a positive, harmonic relationship with nature in children, especially taking into account that half of the world’s population

already lives in cities and the growth of urban population will continue in this century? Also, how could they resist the dominant value system of modern society, i.e. the philosophy of consumerism, growthism, and economism resulting in devastation of natural resources and demoralization of human society?

Parents' attitude and behavior (i.e. living example) toward nature as well as children's early education regarding these issues are the key factors in formation of harmonic relationships between future citizens of the world and their home, the planet Earth. In this society, where young people are heavily bombarded from early childhood by "ideals" of consumerism, individualism, and materialism, the role of parents is invaluable. Their power to instill and carefully cultivate in their children the sense of wonder, awe for creation, and love for nature is difficult to overestimate.

The same is true for their first teachers. It is so easy to point kids' attention to the beauty of the world and to help them to realize how miraculous it is. Field trips, science projects, guided by their instructors with tactful and inspiring approach, and even simple observations of protozoan and microorganisms' life under a microscope could awaken in them a loving, affectionate, and respectful attitude toward nature and creative interest for life as a great and wonderful phenomenon, for the rest of their lives.

There are several ways to bring wilderness to children's lives: trips out of town, walks to the city parks, visits to museums, botanical gardens, zoological parks, aquariums, planetariums, and opportunities to have pets, small gardens or indoor plants. Parents and children can also read books, watch movies about nature and people who are passionate about nature, and discuss them together, go to the concerts and inspire kids to perform themselves, participate together in the events like workshops, meetings, and



festivals that seek to harmonize human activities with nature, to establish true values, and to set appropriate social norms (like the Common Ground Country Fair in Maine); and on this path, parents and teachers should always use opportunities to inform children about real dangers of the deteriorating environment and global problems in each appropriate case, and to explain to children how they could minimize negative impacts.

Hence, there is an array of possibilities that are open for parents and teachers to help children establish and practice their connection with nature, i.e. to raise future adults prepared to take responsibility and proper care for our planet. It is remarkable that most of the above techniques are as good for adults as for children because, independently of our age, there is a hidden child in each of us. The only specificity is that grownups can develop their kinship with nature consciously and purposefully, especially through practicing variable meditating techniques in natural settings. Thus there are the ways “for modern men and women to preserve and enhance their sense of wonder about nature to recover our basic kinship with nature. We need to encourage people of all ages to get out into the natural world and allow themselves to experience the beauty, wonder, and magic that is there” (Swan, 1995).

Importantly, the famous psychologist Abraham Maslow who for a number of years studied “the potentiality of people to be extremely healthy and productive” and as a result coined the term “‘self-actualization’ to describe the people who seemed to be exceptionally psychologically healthy, and in the process helped give birth to the fields of humanistic and transpersonal psychology to describe the more positive dimensions of consciousness and health,” observed that “all the self-actualized people he had studied

seemed to have a deep reverence for nature and took delight in natural beauty” (Swan, 1995, 174).

Certainly, Vernadsky represents a great example of the self-actualized people and adds sound evidence to Maslow’s observation. Beginning from his childhood, Vernadsky was in close contact with nature both in his personal life and career; as a student doing research on the soils of the Russian steppe and as a geologist in his earlier career, covering huge spaciousness of Russia either in a cart/wagon or by foot, which spared enough time for him to contemplate on the beautiful and diverse landscapes of Russia. He was a passionate hiker and often brought from his walks wild flowers that he loved so much to his wife Natasha – a close friend, a companion, a partner, and a woman he loved and with whom he lived for 56 years before her death in 1942, just two years before his death. I believe that typically, Vernadsky’s walks were in its essence the walking meditations when he thought over, developed, and shaped his innovative scientific and philosophical insights.

Vernadsky’s love for nature shines even through his scientific writings written, in accordance with a classical academic tradition, in a concise and impartial manner. Interestingly, he could not resist but to begin his infamous *The Biosphere* (1926) with the quatrain from his favorite Russian Romantic poet Fyodor Tyutchev (1803-1873) whose lyrics praised the beauty and harmony of nature. Also noteworthy, as it was shown above, how he started his first paragraph of *The Biosphere* – a look at Earth from space. Vernadsky had broad cultural interests and not only loved but knew very well arts, music, poetry, and literature. He believed that science, arts, philosophy, and religion are just different manifestations of spiritual activity, and are incomplete if not related to each

other. It appears that Vernadsky's love for and his spontaneous but regular contemplations on nature are seemingly a part of what his biographer, Rudolf Balandin, described in his *Vladimir Vernadsky* book (1982, p. 79-80):

Vernadsky possessed the striking ability to see the great and large in the small, to move from the specific to generalizations. In the words of William Blake

To see a World in a Grain of Sand,  
And a Heaven in a Wild Flower,  
Hold Infinity in the palm of your hand,  
And Eternity in an hour.

To awaken (because it is inherent to humans), to develop, and to cultivate this capability in their students is a challenging but doable, noble, and enjoyable task of educators at all levels, including parents, teachers, and faith community leaders. And here again, Vernadsky's biosphere and noosphere theory could be of great help for it places all educational activities in the context of "cosmic reality." Children are our future – they are future citizens of this world. No matter whether they are our own children or our relatives' children, children from our neighborhood or students in our class, it is our common task and responsibility to engage them in all possible activities to reinforce their connection with nature for building a positive, harmonic relationship with our home, the planet Earth. All children belong to all of us, a global community of humans on this planet, because they are carriers of our unique, humane culture through time and space.

### **Positive Experiences of Integrating Vernadsky's Ideas into Curriculum.**

As it was argued earlier in this chapter, the familiarization of students with Vernadsky's theory of the biosphere when delivering the sustainability message is very

important, which is why Vernadsky's theoretical system could, and should in the author's conviction, be consciously integrated into curricula as a scientific and philosophical basis for sustainability education. This would allow educators to use it to full capacity, i.e. very effectively and efficiently for three major reasons. Firstly, Vernadsky's ideas could be well condensed just to one lecture with the following discussion and group work. Secondly, they should also serve as the conceptual framework that integrates all knowledge to be delivered in the course as seen from the biospheric perspective, irrespective of the discipline under consideration. Thirdly, Vernadsky's ideas, as both professors and students emphasize, are easy and enjoyable to grasp, and his thought does not require specific scientific background or education as it is well shown below in this section where I will share my positive pedagogical experiences in incorporating Vernadsky's ideas into the IA501 Global Issues in International Affairs curricula as well as presentations to various audiences varying from K-12 to college students, educators, and the general public Appendix 3 provides a list of my Vernadsky- and biosphere/noosphere-related presentations given to variable audiences over the last few years.

Just delivering a sustainability message as the need or a requirement of our time as well as illustrating a sustainability concept typically as three intercrossing spheres of economy, society and nature/environment is good but not sufficient to personally motivate people for sustainable living and acting. It is too abstract distant, and dry. If Vernadsky's concept of the biosphere is used in sustainability education, it simultaneously and integrally touches upon several important dimensions of human

nature, irrespective of human age, background and culture, and the positive examples will be provided below in this section.

As Thomashow (2002) emphasizes in his book *Bringing the biosphere home: Learning to perceive global environmental change*, in environmental or sustainability education it is necessary to relate the power of Vernadsky's biosphere message to people's personal experiences (p. 109):

I have an intuition of biospheric perception... Surely the movement and energy here is intricately complex, inconceivably variable, replete with cycles and patterns, more involved than I can ascertain. Vernadsky suggests that the biosphere contains layers and levels of movement, most of which are imperceptible, hence his implied challenge – how to grasp the subtleties of changes that may otherwise pass you by...

Just as Darwin's legacy of evolutionary biology allowed for the reconceptualization of the origins and development of life, so does Vernadsky's legacy of Earth systems science inspire the reconceptualization of the earth. Both legacies imply perceptual demands that are barely incorporated in most educational settings...

Vernadsky's perceptual challenge is an educational imperative – how to look at the world from a biospheric perspective.

Thomashow justly emphasizes (2002, p. 2) that the potential of Vernadsky's biosphere message could be used in a full capacity if combination of “good science, imaginative metaphor and compassionate identification” is in place. And below there are presented some of my positive experiences of incorporating Vernadsky's concept of the biosphere and noosphere into the pedagogy of teaching sustainability.

For example, the narrative about Russian Cosmism and Vernadsky's biosphere theory delivered together with the remote sensing images of Earth and other planets/stars/galaxies, could certainly extend students' horizons, and enrich their intellectual experience. This is especially important when addressing sustainability issues to non-majors in natural resources or environmental studies, because the cultural and

spiritual component of this information would appeal to their interests in various dimensions of human culture that Russian cosmism encompasses.

Independently of their major discipline/orientation, all students would be thrilled to know that Fedorov, the founder of the Russian Cosmism school, predicted that humans will inhabit the whole cosmos at some point in their distant future and will be able to change purposefully climate on Earth and other planets. Some call it idealism or utopia; but history has proven that many predictions of Russian cosmists became true.

For example, it is astounding to learn that Fedorov (1829-1903) was a teacher of Konstantin Tsiolkovsky (1857-1935), who is recognized worldwide as the father of modern cosmonautics. In turn, Tsiolkovsky was a mentor of Sergei Korolev (1907-1966), the general constructor of the Russian Space Program and launched the first satellite, *Sputnik*, into space in 1957 and later a number of Soviet cosmonauts. In his turn, Korolev was a supervisor of Yuri Gagarin (1934-1968), the first cosmonaut in the history of humanity that entered space in 1961. Gagarin was also the first man who saw live images of Earth from space and exclaimed: “I see Earth. It’s so beautiful!” These are the first words spoken by a man in space.

My teaching experience both in academic environment and in public presentations shows that, when used together, the images of remote sensing obtained from space and the cosmic perspective that is embodied in the noosphere notion make them a powerful tool in transforming people’s worldview, broadening their vision of our place not only on Earth but in the Cosmos, and motivating them for more sustainable life styles.

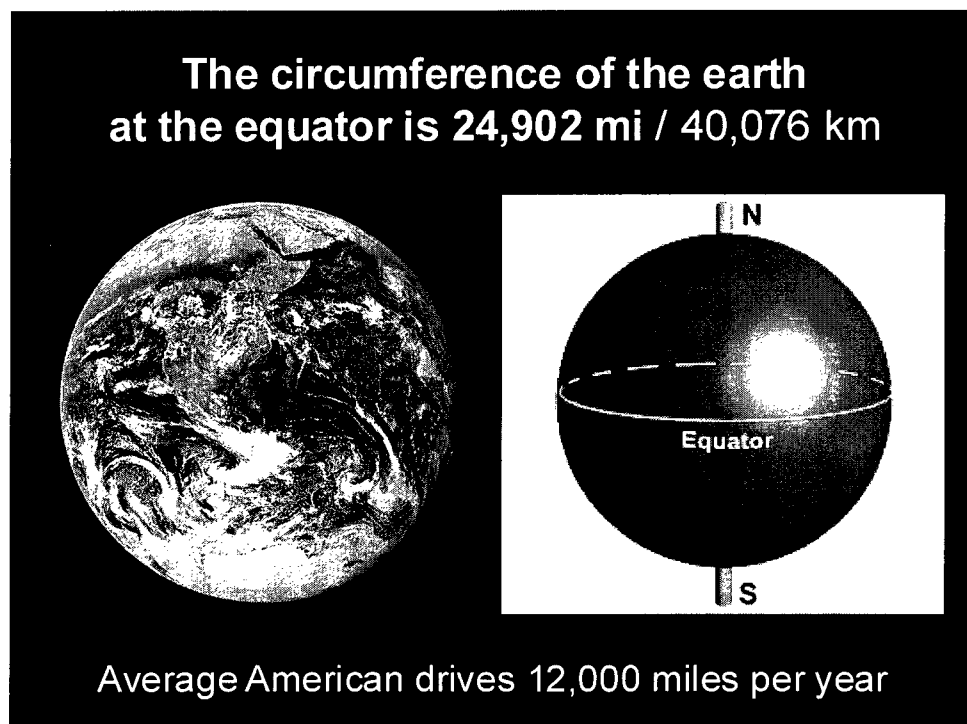
According to Lillesand et al. (2004), “*Remote Sensing* is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data

acquired by a device that is not in contact with the object, area, or phenomenon under investigation.” Elachi (1987) gives one of the broadest definitions of remote sensing: “*Remote Sensing* is defined as the acquisition of information about an object without being in physical contact with it.”

The major and powerful message remote sensing images could add to noospheric and/or sustainability education is that our home, planet Earth, is a place of astonishing uniqueness and beauty. Also, as an educator, I see the use of remote sensing images in my teaching as not only an affective tool for addressing contemporary ecological problems and principles of sustainability, but also as a means to address other dimensions of society-nature interaction (including economics, politics, wars and conflict, poverty, human rights, etc.), and in the first place — ethical issues, values, and responsibility.

As an example of the successful use of remote sensing images to enhance students’ understanding and learning about the Earth system and Vernadsky’s biosphere and noosphere concept, I could reflect on my own positive experience with majors and non-majors in natural sciences, as well as the public. I developed a method of conveying information about our place in the earth system and how it relates to the entire universe. As a foundation in constructing this method, I incorporated Dr. Eberhard Möbius’s Pocket Solar System that he uses in his introductory lecture on astronomy at UNH. The goal of my method is to put the audience into a position in which they could imagine their place in the universe using the knowledge of space science so that they would realize through their imagination the uniqueness of our planet and our responsibility for it.

Usually, I start my lecture by questioning the audience on where we live. There is a range of answers, among which at least one member responds: “The Earth.” Immediately after that, I expose the beautiful image of the Earth (taken by Apollo 17 in 1972). My next question is, “Is it a big or small place?” Again, answers usually vary, and I say, “In trying to find your answer, estimate your annual mileage.” Here, I use another tool of active learning—discussing this question with a partner. Most often, the answers fall into the statistical average mileage of Americans. Then I show the audience how this mileage relates to the size of the Earth by portraying the mileage as a circumference of a sphere next to the image of the Earth (*Figure 3*).



*Figure 3.* Sample slide from author’s PowerPoint presentation, demonstrating use of remote sensing images to enhance and students’ understanding about the Earth system and Vernadsky’s biosphere and noosphere concept.



Thereby the audience is astonished to know that every American, on average, drives the Earth's circumference on a two-year basis. Then, I show the next slide of the solar system, emphasizing that our planet is the only living planet in our solar system.

Then, I use Dr. Möbius's Pocket Solar System by asking how big the planets of the solar system are compared to the sun if the sun were represented by a Styrofoam ball. However, instead of the ball, I hold a large grapefruit in my hand. Then follows our discussion on the size of the Earth and other planets, whose comparisons vary from the head of a shirtpin (e.g. Earth and Venus) to a little dot/poppy seed (e.g. Mercury) to a quarter (Saturn's rings) to a marble (e.g. Jupiter). Together, we come to the conclusion that planet Earth is a unique living planet in our Solar system (later we discuss this again, in the known Universe scale). Then, I ask what they think about the size of our solar system, which in this scale could occupy downtown Durham. Further, I ask the audience about where, in this scale, the closest star (Alpha Centauri) would be. Assumptions vary from Somersworth to Boston, usually. Therefore, they are astounded to discover that in fact the closest star in this model would be found in San Francisco. Thus, Dr. Möbius's tool turns out to be an extremely effective way to engage any audience and assure their comprehension of this topic.

Usually, I "travel" further through space with my listeners, continuing to pose questions and revealing more information, along with more remote sensing images. Through our voyage, students learn that none of the specific planetary missions so far have detected life on other planets. I finally finish with the images of the clusters of galaxies. After my audience really understands the place of our Earth in the known universe, I switch gears to zoom back into discussing the most pressing problems of the

society-nature interaction on our unique planet Earth, like population growth problems, global warming and climate change, ecological footprint, etc.

This is just an example of how effectively remote sensing images can be used in teaching sustainability and as support for explaining the biosphere and noosphere concept of Vernadsky. The way of teaching could vary – to my mind, the best combination is lecture-discussion-seminar format; it could include small group work, in class-writing essay, field trips, games and other experiential learning techniques. This way of teaching sustainability incorporates the cognitive information-processing principles (de Winstanley and Bjork, 2002) that make the teaching/learning process very effective. Also, this way of conveying information meets the multifunctional principle by addressing and fulfilling several pedagogical tasks simultaneously, as well as the principle of multiple intelligences. One of many possible and effective applications of how to bring Vernadsky's biospheric perspective into the classroom, which would serve thereafter as a conceptual framework for the pedagogy of teaching sustainability, is a 20-minute lecture, which I developed using cognitive theory principles, which description is provided in Appendix 4.

One more of my many successful experiences to deliver Vernadsky's biosphere and noosphere message which is the assigning, just before my lecture on this matter, to IA501-students<sup>26</sup> the reading of Vernadsky's "The Biosphere and the Noosphere" paper published in *American Scientist* in 1945 and their journal reflection on it.

Typically, most of the students started their written reflection complaining that this was a difficult "scientific" paper for them (they are not majoring in science, but in

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<sup>26</sup> IA501 Global Issues in International Affairs course is a required course for dual majors in International Affairs at the University of New Hampshire, which typically includes a very diverse group of students in terms of their educational and cultural backgrounds, majors, age, ethnicity and nationality.

humanities, business, economics, politics, etc.). However, after having come through this process, they were able to grasp Vernadsky's brilliant ideas and grandiose picture of the world, and were grateful for becoming aware of his ecocentric/cosmic perspective and inspiring notion of the noosphere. What amazed me most of all in the above experiences, when I taught for four semesters the International Affairs majors, was not only that students were able to understand the essence of Vernadsky's biosphere concept from this old scientific article written with unusual language compared to today, but the fact that before I introduced them to Vernadsky and his theory, students were able, based on this reading, to relate Vernadsky's ideas to today's problems like global warming and climate change and would associate his noosphere with the need for humanity to switch to a sustainable path. Also, they appreciated Vernadsky's scientifically based optimism embodied in his theory, which is so needed in our time of uncertainty and despair.

The same has been happening during my PowerPoint presentations about Vernadsky's theory of the biosphere and the noosphere both in academic environments, professional courses, and in public presentations; some people have been providing me with a positive feedback for a long time thereafter, sharing how the new knowledge about the noosphere which they gained was spreading among their associates in a chain reaction.

And finally one more, a short and time-saving but very sound exercise – the “Sun-Rays” exercise as I call it. On a warm sunny fall or spring day, after giving a lecture on Vernadsky's biosphere and the noosphere and “traveling” through the universe described above, I bring students outside and suggest they sit in the sunlight with their palms open and catch the sun rays, knowing that if they looked at the sun and imagine that sunlight

travels 8 minutes to reach the Earth, then in 8 minutes they will have on their palm, literally speaking, the sun radiation that left the Sun when they looked at their watches 8 minutes ago. This is a great meditation and takes only about 10 minutes, when students sit quiet and enjoy sunshine, imagining how sunlight travels through space to reach them here and now. It is an unforgettable experience and I myself enjoy thoroughly this exercise each time. Then Vernadsky's words from his *The Biosphere* (1926) sound so alive:

The biosphere is as much, or even more, the creation of the Sun as it is a manifestation of Earth-processes. Ancient religious traditions which regarded terrestrial creatures, especially human beings, as 'children of the Sun' were much nearer the truth than those which looked upon them as a mere ephemeral creation.

Another interesting observation and experience is that my presentation of Vernadsky's biospheric message to the audiences with a very limited scientific background shows that we often underestimate people's ability to grasp the power of rather complex scientific knowledge if it is brought in an appropriate form. For example, during my talks with K-students at the Dover Elementary School during the 2009 Earth day, I was stunned by their ability to participate in the discussion and to willingly answer biosphere-related questions like what is energy and their personal examples of energy at work, or giving examples of living and non-living components of an ecosystem, and so on<sup>27</sup>. Also, Barry Rock's PowerPoint talk that he has given at the opening of this Earth day (i.e. before my workshops for K-students), was very helpful; he engaged K-4 students into the imaginary space trip through the Solar System with short stops at each

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<sup>27</sup> Certainly, I used the language and instances that were understandable from their age perspective and experience.

planet, exploring each of them individually whether it is inhabitable for human life or not; it was obvious that this helped children to realize how lucky we are to have as a home a unique and precious planet – the Earth. Therefore, when thereafter children came to my workshop, they were already prepared to grasp some ecological and biospheric features of Earth as a global ecosystem and relate it to their personal life and experiences. They left the classroom inspired and enthusiastic.

Indeed, as it was emphasized in the section about the DESD, there is great space for an educator's creativity and initiative in teaching sustainability. But the bottom line is that all activities and measures toward sustainability, including for example such a trivial thing as replacing light bulbs for energy-efficient ones, should be placed into the context of the biosphere or systems thinking perspective; then people would care about the consequences of all their deeds (however sustainable they would look at the first glance) and, as in the latter example, they would take care of properly recycling the energy-efficient bulbs because they contain mercury, an extremely toxic element for the living matter of the biosphere, including humans.

### **Why Vernadsky's Biosphere Theory Should be Integrated into Education**

As was shown above, Vernadsky's theory of the biosphere is the most encompassing, synthetic scientific theory that is at the core of the modern scientific paradigm. It is also ecological and holistic worldview which is the indispensable prerequisite of the concept of sustainability and sustainable development. Although the world recognized the importance of universal sustainability education in order to switch to sustainable development, and we now live through the sixth year of the United Nations

Decade of Education for Sustainable Development (DESD, 2005-2014), a common conceptual approach or model of sustainability education does not yet exist.

This creates a challenge for educators to apply the concept of sustainability, a concept which is still too broad and vague, and does not help the teaching of sustainability to be an effective and efficient process. Absence of a common conceptual approach to sustainability education manifests, unfortunately, the existing compartmentalization of knowledge and reductionism in science and education. But because of the seriousness of the challenges of the global crisis, we cannot wait until the conceptual model or common approach will be elaborated, accepted, applied, and implemented.

As it is shown in this work, the optimal solution seems to be to start – *consciously* and *right now* – to apply as a universal approach to sustainability education Vernadsky's theory of the biosphere which, as it was shown above, could be identified in a few words as scientific, ecological, holistic, and optimistic, and thus embodies all major qualities needed for promoting and cultivating an ecological and holistic worldview. My multiple, diverse, and positive experiences of using Vernadsky's biosphere theory as a conceptual framework for addressing the sustainability concept show that it works very effectively and efficiently in various educational settings.

Why should Vernadsky's theory of the biosphere and the noosphere be integrated in sustainability education? Simply stated, because it is ecological, holistic and optimistic, i.e. it embodies the qualities that are crucially important, as was shown in Chapter 1, for the formation of an ecological and holistic worldview, which in turn is an absolutely needed prerequisite for switching to sustainable development on a massive

scale. However, Vernadsky's theory of the biosphere and the noosphere contains even more potentialities for making the process of teaching sustainability even more effective. As is shown in the above research, Vernadsky's theoretical system should be consciously integrated in universal sustainability education and serve as a context for all educational activities because it is:

1. **Scientific** and is at the core of the modern scientific paradigm, Earth sciences, global ecology, sustainability concept, and conservation. Vernadsky "offered the mankind a teaching that can be treated today as **a science of the third millennium**" (Guegamian, 2006, p. 36). Vernadsky's theoretical system is about co-evolution of life and physical environment on Earth and the functioning mechanisms of Earth's biosphere as a complex, integrated, dynamic, and self-regulating living system. "Vernadsky's name has become more popular in the past decades primarily because he treated global human problems scientifically, as a naturalist" (Balandin, 1988, p. 7).
2. **Interdisciplinary**<sup>28</sup> as it embodies knowledge not only of many disciplines within the field of physical and natural sciences, but also from humanities and social sciences. "The study of the biosphere cannot be made by only biologists. To study its components and their interactions, a multidisciplinary approach is needed. However, at Vernadsky's times nobody even thought of interdisciplinary" (Grinevald, 1998).
3. **Deeply ecological and holistic, i.e. antireductionist** as it shows all elements of the whole Earth system, including living and nonliving matter, in its intimate interconnectedness and interdependency. "Thus, Vernadsky's synthetic view of the biosphere ultimately embraces the geological, biological, and human forces that change and determine the face of the Earth. The most important implication is that these forces are considered deeply interconnected" (Ghilarov, 1995, p. 198).

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<sup>28</sup> Interdisciplinary – crosses traditional boundaries between academic disciplines or schools of thought (Wikipedia encyclopedia, 2010).

“Already in the beginning of the [19]30-s Vernadsky came to the idea of writing a book where his holistic view on the nature both would be expressed both scientifically and ‘philosophically’” (Levit, 2001, p. 14).

4. Embodies and simultaneously clearly demonstrates **the Systems Thinking** approach, i.e. a conceptual framework when functioning of all component parts of a system, including its own subsystems, considered in the context of their relationships rather than in isolation and independency. “Vernadsky was a truly global systems thinker who was one hundred years ahead of his time” (Volk, 2007).
5. **Spiritual**<sup>29</sup> in its essence as it scientifically confirms such highest human values and aspirations as oneness of all life and its intimate interconnectedness with the physical environment, both nonliving and living matter (including people), and the planet Earth on the whole as an organic and lawful part of the “cosmic reality.” Vernadsky believed that “one cannot perceive scientific truth [only] by logic” and considered all other forms of spiritual activity such as art, philosophy, and religion as playing “an important role in the development of science” (Levit, 2001, p. 37).
6. **Highly humanistic** as it does not only manifest but scientifically justify the unity and equality of all humans, independently of their race, age, cultural backgrounds and other diversities: “Mankind became a single totality in the life on earth... Geological evolutionary process shows the biological unity and equality of all men, *Homo sapiens* and his ancestors, *Sinanthropus* and others; their progeny in the mixed white, red, yellow, and black races evolves ceaselessly in innumerable generations... *This is a law of nature*... I use here the phrase ‘the law of nature’ as this term is used more and more in the physical and chemical sciences, in the

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<sup>29</sup> In this work, *spirituality* is defined (Chapter 1) as people’s highest values, feelings, and aspirations: awe for creation; reverence for life; connection with and love for nature; a sense of wonder, appreciation of harmony and beauty of the universe; oneness with all humanity, living and non-living world; gratitude and a desire for the common good.



sense of an empirical generalization established with precision” (Vernadsky, 1945).

7. **Optimistic** in its nature because of its cosmocentric worldview, which is fostering thereby the highest human feelings and aspirations; it shows our uniqueness, our genuine place and mission in the Universe as cultural creatures, and thereby gives a hope for a positive future for the human race and motivates people to act right now. His optimism is also rooted in scientific evidence that evolution is directional and he considered “consciousness as a natural force” (Levit, 2001, p. 34) that in the end cannot act against itself. As Hutchinson (1970) remarked, “Vernadsky’s transition [to the noosphere] in its deepest sense is the only alternative to man’s cutting his lifetime short by millions of years.”
8. **Straightforward and clear conception**, which is understandable for an average person and does not require any special educational background in science. “Vernadsky’s creative genius can be understood by almost any educated person,” observed Vernadsky’s biographer and the author of a captivating book about him, Rudolph Balandin (1982, p. 205). Moreover, as many modern scholars observed, Vernadsky’s original writings are also enjoyable. Livingstone (2005) even says that Vernadsky describes the biosphere not only scientifically but also poetically, which was shown above. American biology professor Frank B. Salisbury, who came four times through the manuscript of Vernadsky’s *Essays on Geochemistry* and *The Biosphere* when editing its English translation from Russian, wrote in 2007 (p. i): “Editing these two examples of Vladimir Ivanovich Vernadsky’s writings through three and more readings has been a most interesting and rewarding experience. Vernadsky’s writings are such an enjoyable read because there are several kinds of insights that one may gain from these two works.” Strikingly, not only professors and researchers understand and admire Vernadsky’s thought. What I found through my teaching, is that many of my young, modern, and diverse A501 Global Issues in International Affairs students, after reading Vernadsky’s “The Biosphere and the Noosphere” paper in *American*

*Scientist* (1945), reflected that the reading was thought-provoking, eye-opening, and extremely relative to today's global problems.

9. **Relevant to our time and global problems of today**, which manifests itself through explosive spontaneous growth of interest in and popularity of Vernadsky's scientific and philosophical legacy and growing number of English-language original and Vernadsky-related publications in the West. In 1993, Yanshin pointed out that "the main reason for appreciation of Vernadsky's work is our urgent "necessity of a complex holistic conceptual approach" to the problems of increasingly and rapidly deteriorating environment and impending global ecological crisis." Today, in regard to the long-awaited release of Vernadsky's *Geochemistry and The Biosphere*, the Chief Executive of Synergetic Press, Deborah Snyder says (2007): "The publication of these essays, written over sixty years ago, comes at an auspicious time. We have reached a point on our planet when serious debate on what to do about global warming can no longer be postponed – an understanding of Vernadsky's work on the biosphere and noosphere is absolutely central to such conversations. It is our hope that bringing Vernadsky's ecological vision to the English-speaking world will help deepen our understanding of planetary processes and enable us to become better stewards of our planet." Indeed, my four-semester teaching of IA501, Global Issues in International Affairs class at UNH, and multiple presentations given to high school through college students (both undergraduate and graduate), as well as my presentations for the general public and at professional meetings (including interdisciplinary settings) persuasively showed that people of different background and age enthusiastically perceive Vernadsky's vision of the biosphere and the noosphere. Most of all, people are usually impressed by Vernadsky's notion of the noosphere as an inevitable and natural process of human-nature co-evolution and its direct relevance to today's global problems, both environmental and societal. People admire Vernadsky's idea of the noosphere because it provides hope and optimism so much needed now because of all the discouraging information about the developing global ecological crisis that encompasses all

spheres of human life. Quite often after presentations, people reflected that Vernadsky's ideas are very inspiring and motivating, and that they are very grateful for introducing them to Vernadsky.

All the above qualities of Vernadsky's theoretical system I discovered in the process of reading his writings and Vernadsky-related publications, but most of all through the process of integrating his ideas into teaching activities in different educational settings, trying to find out purposefully and experientially what pedagogical practices work most effectively and efficiently in terms of sustainability education.

As my experience shows, both the above tips and the approaches that I described in the previous section, could be successfully applied by educators of any level and in various settings ranging from college teaching to professional meetings to presentations for K-12 student and the general public. What is important for educators to keep in mind, though, is that Vernadsky's theory of the biosphere should serve as a universal conceptual framework, a general context for all educational activities in order to cultivate "biospheric perception" in Thomashow's definition (2002, p. 111) which is the key to our sustainable future – the noosphere.

## CONCLUSION

New scientific evidence shows that the situation with global warming is worsening much faster than was expected even a few years ago. In 2006, James Hansen thought that we had at most 10 years to act to “reduce greenhouse gases before global warming reaches... a tipping point and becomes unstoppable” (CBS, 2006; McKie, 2009). Only two years later, in 2008, he said that “the situation has gotten so bad that the world’s only hope is drastic action” (CBS News, 2008). In January 2009, based on the most recent evidence that the ice caps of Greenland and Antarctica “are melting at an alarming rate,” Hansen claimed that we have at most only four years left to act quickly to prevent a global catastrophe (McKie, 2009).

Lester Brown, another great mind of our time, urges immediate action before it is too late. In his new book, *Plan B 3.0* (2008), Brown argues that the degree of urgency we are facing now is the same as in a case of war: “Perhaps the most revealing difference between *Plan B 2.0* [2006] and *Plan B 3.0* is the change of the subtitle from ‘Rescuing the Planet Under Stress and Civilization in Trouble’ to simply ‘Mobilizing to Save Civilization’” (Brown, 2008). But who mobilizes citizens to fight global warming and other destructive environmental and societal trends?

Mobilizing people to save civilization means motivating them to act and live sustainably. To ensure this change, people need to be ecologically literate – that is, people need to understand how this planet works, what is going on right now, and what to do about it. In other words, universal sustainability education is needed to convince

people to adopt sustainable life styles and prevent the global catastrophe that threatens civilization.

Indeed, from a systems thinking point of view, education is a pivotal place for enacting societal change (Meadows et al., 2004; Meadows, 2008). If we accept Brown's comparison about urgency between war and global crisis, then educators must consciously become agents for change – the “mobilizers” to recruit people to fight global warming and to deal with other endangering trends. And here is the challenge – sustainability education must become an organic part of the curriculum and any educational activity at every level, both in school and community settings. Are our educational system and educators ready to meet this challenge?

Back in 1994 David Orr, the author of the concept of ecological literacy and one of the loudest and most persuasive advocates for the urgent necessity for humanity to change its course of “technological progress” from destructive to sustainable mode (unless it is too late), calls for the need of educational reform: “Finally, it is time to establish national goals for ecological literacy and make these a vital part of the curriculum of public schools and college.” How much did our formal system of education change since then?

Certainly, there are positive and innovative examples of implementing sustainability education in the college environment, like the Office of Sustainability initiatives at UNH and other American universities, but they are still the exception rather than the rule. It is said that the ongoing ecological crisis is, in the first place, a crisis of values and spirituality. The importance of values and ethics for a successful transition to our sustainable future is strongly emphasized in the program documents of the United

Nations mentioned in this study earlier. The understanding of this is growing. For example, the participants of the United States Faculty Development Workshop “Ethics, Science, and Civic Responsibility” (2004) concluded, “while many college-level environmental programs in the United States offer courses on environmental ethics, the overarching goal of devising tools for systematically examining environmental ethics and values in social science and natural science curricula is under-achieved” (Faculty Development Workshop, 2004). However, not much has been done since then. It is clear that sustainability education must become a mandatory requirement at all levels of education and for all educational institutions if our efforts to switch to a sustainable mode of further development are serious.

However, there are warning signs that something in the U.S. educational system is going in the wrong direction. For example, in 2006 the OECD<sup>30</sup> Programme for International Student Assessment (PISA) conducted the New Environmental Literacy Study that ranked U.S. students below most other countries (PISA, 2006). The article says (Campaign for Environmental Literacy, 2009; NCES, 2007): the “USA ranks 34<sup>th</sup> out of the 57 countries surveyed in both environmental science and geoscience, and is consistently below the OECD averages in almost all categories. True, we beat out Uruguay and Thailand. But we fell below Estonia, Croatia, and the Slovak and Czech Republics as well as Canada, Japan, Australia, Russia, and the UK.”

Another recent disappointing example relates to the global level – a failure of the Copenhagen climate change conference (Arguelles, 2010):

The recent United Nations Copenhagen Conference on Global Warming (December 8-18, 2009) was a failure of the collective human will to act

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<sup>30</sup> OECD – Organisation for Economic Co-operation and Development.

decisively in the face of a life-threatening crisis. This is because the present world leadership represents various levels of competing or conflicting interests that could not be resolved. None of the leadership at the Copenhagen conference seemed to neither comprehend the Earth as a whole system nor be able to speak on its behalf above all personal or collective self-interest.

The fact is, that unless there is a world leadership committed in its decision making process to principles of a planetary whole system design science, the human species will forfeit its future.

There are now but three years to find such a leadership willing to adopt and implement these principles. Even if such leadership cannot be gathered, it is nonetheless necessary to articulate the principles of a comprehension of the Earth as a single unified system. The elementary principles of a post- or meta-nationalistic thinking – planetary whole system design science – must be defined in light of the geological transition from the biosphere to the noosphere, and of the inexorable path of cosmic evolution, which is toward ever-greater states of conscious unification.

Indeed, as Thomas Friedman (2008, p. 397) exclaimed: “It is much more important to change your leaders than to change your light bulbs.” In this connection Arguelles (2010) writes:

In 1944, V. I. Vernadsky wrote, “Statesmen should be aware of the present elemental process of transition of the Biosphere into the Noosphere. The fundamental property of biogeochemical energy is clearly revealed in the growth of the free energy of the biosphere with geological time, especially in relation to the transition into the noosphere. ... Only man transgresses the established order ... upsets the equilibrium, though whether he materially cripples the transforming mechanism or merely redistributes it, we cannot at the moment be sure.

What Vernadsky cautioned about over sixty years ago, we are now witnessing as an alarming crisis of potentially catastrophic proportions. While statesmen and politicians are slowly waking up to the reality of global warming, the failure of *the Copenhagen Global Warming Conference has demonstrated that a much greater education process is needed in order to understand that climate change and the crisis of civilization are both aspects of a much larger event – the biosphere-noosphere transition.*<sup>31</sup>

As shown in this study, more and more advanced minds of our time are calling for the need to educate people with Vernadsky’s biospheric perspective and to purposefully

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<sup>31</sup> Italicized by I.T.

cultivate a “biospheric perception” (Thomashow, 2002), which provides an intimate connection of each individual with the whole biosphere.

Indeed, the potential of Vernadsky’s theory of the biosphere and the noosphere as a conceptual framework for science and sustainability education is enormous. As it was shown above, although the global community recognized the need for a universal sustainability education, the common conceptual approach or model is still missing. However, Vernadsky’s theory of the biosphere and its transition into the noosphere could be successfully and effectively applied by educators as a conceptual framework to sustainability education/teaching sustainability right now because, as it was shown through this entire work and specifically in Chapter 4, his theoretical system is:

1. Scientific and is at the core of the modern scientific paradigm, Earth sciences, global ecology, sustainability concept, and conservation.
2. Interdisciplinary<sup>32</sup> as it embodies knowledge not only of many disciplines within the field of physical and natural sciences, but also from humanities and social sciences.
3. Deeply ecological and holistic (i.e. antireductionist) as it shows all elements of the whole Earth system, including living and nonliving matter, in its intimate interconnectedness and interdependency.
4. Embodies and simultaneously clearly demonstrates the Systems Thinking approach, i.e. a conceptual framework when functioning of all component parts of a system, including its own subsystems, considered in the context of their relationships rather than in isolation and independency.
5. Spiritual<sup>33</sup> in its essence as it scientifically confirms such highest human values and aspirations as oneness of all life and its intimate interconnectedness with the

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<sup>32</sup> Interdisciplinary – crosses traditional boundaries between academic disciplines or schools of thought (Wikipedia Encyclopedia, 2010).



physical environment, both nonliving and living matter (including people), and the planet Earth on the whole as an organic and lawful part of the “cosmic reality.”

6. Highly humanistic as it does not only manifest but scientifically justifies the unity and equality of all humans, independently of their race, age, cultural backgrounds and other diversities.
7. Optimistic in its nature because of its cosmocentric worldview, fostering the highest human feelings and aspirations; it shows our uniqueness, our genuine place and mission in the Universe as cultural creatures, and thereby gives a hope for a positive future for the human race and motivates people to act right now. As Hutchinson (1970) remarked, “Vernadsky’s transition [to the noosphere] in its deepest sense is the only alternative to man’s cutting his lifetime short by millions of years.”
8. Straightforward and clear conception, which is understandable for an average educated person and does not require any educational background in science.
9. Relevant to our time and global problems of today.

Indeed, Vernadsky’s popularity is growing now because his ideas and holistic theoretical system are very relevant to our time and in demand now, as it was shown in this study. As Yanshin (2007, p. xviii) writes: “Vernadsky’s teaching not only prepare the ground for planetary thinking, but also exemplify a full-scale understanding of the unity of the planet’s living and non-living nature and the unity of the planet with cosmic environment. This unity is the gist of Vernadsky’s teaching.” And here is his farewell testament to scientists (of all times) that sounds so timely today (quoted in Yanshin, 2007, p. xviii):

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<sup>33</sup> In this work, *spirituality* is defined as people’s highest values, feelings, and aspirations: awe for creation; reverence for life; connection with and love for nature; a sense of wonder, appreciation of harmony and beauty of the universe; oneness with all humanity, living and non-living world; gratitude and a desire for the common good.

... in 1920, he [Vernadsky] privately recollected: “I have long been surprised at the lack of desire to embrace Nature as a whole in the field of empirical knowledge, whereas it is within our grasp to do so. Often we as scientists give only a mere collection of facts and observations where actually we could present the whole...It looks like some mental laziness. We feel that if we make an effort, we can rise to embracing the phenomenon as a whole, but this effort is not made, and judging by the literature nobody makes it.” Only much later, in the second half of the twentieth century, was this approach in science widely realized, acknowledged, defined and called integrative, systematic, global, etc.

Guenze V. Guegamian (2006) nicely and succinctly summarized the importance of Vernadsky’s biosphere theory for us today (p. 36):

At the end of 19<sup>th</sup> century, a man began his scientific research in Russia, generalized the observations of a number of eminent scientists of Europe, and offered the mankind a teaching that can be treated today as a science of the third millennium. I refer to Vladimir Ivanovich Vernadsky (1863-1945) and his teaching about living matter and the biosphere – about biospherology. It is not common in history of science for both the teaching and ideas developed by one scholar to become eventually an independent science. V.I. Vernadsky’s teaching about living matter and the biosphere is one of such lucky exceptions

Remarkably, in addition to the independent science of biospherology, identified as “a science of the third millennium” by Guegamian above, Vernadsky was also a founder of biogeochemistry, radiogeology, and cosmochemistry as it was shown above.

As also shown above, Vernadsky built his biosphere theory based both on his own research and philosophical insights, as well as using knowledge and up-to-date data from many fields, including astronomy, geology, chemistry, physics, mathematics, biology, soil science – just to mention a few. However, the scope of synthesis he accomplished in his biosphere concept became possible not only because of his unique background as a scientist, philosopher, and a historian of science, but essentially owing to his unique mind-set and a new, revolutionary level of thinking which in modern terms could be defined as a holistic, interdisciplinary, and systems thinking approach. Vernadsky was

not only a polymath and generalist (i.e. a person of encyclopedic knowledge and an expert in many fields), but also one of the pioneers of systems thinking. Dennis Meadows, who is one of the founders and recognized gurus in Systems Dynamics (Meadows et al, 1972, 2004), to my question if he knows Vernadsky, responded; “Of course: he is one of the earliest geniuses in systems thinking!” (personal communication from Dennis Meadows, fall 2005).

Indeed, not many people can be polyglots<sup>34</sup> or polymaths. A very special few can have encyclopedic knowledge. Even less can be experts in and possess knowledge and skills within many fields. Only the exceptional can cross interdisciplinary borders of many sciences. But only a rare few gifted individuals can show themselves to be geniuses – unique and synthetic minds capable of comprehending all of the available knowledge at their own time and breaking through the existing paradigm, thereby shifting the limits of human understanding and perception. Vernadsky was one of them.

Someone could naturally wonder whether Vernadsky was conscious of the scope of the scientific generalization and the importance of the synthesis of knowledge he was elaborating at the beginning of the 20<sup>th</sup> century. Vernadsky’s diaries give a certain answer to this question. For example, as early as in 1913, Vernadsky wrote in his diary: “The kingdom of my ideas is ahead.” At the same time, Vernadsky knew as an expert historian of science that it usually takes dozens if not hundreds of years for a new scientific paradigm to become a generally accepted worldview. In 1919 he wrote in his diary (Balandin, 1982, p. 107)<sup>35</sup>:

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<sup>34</sup> Vernadsky knew 15 European languages and was able to write his scientific papers and deliver lectures in French, German, Russian, Polish and Ukrainian (Balandin, 1982; Kauffmann, 1991).

<sup>35</sup> Original Russian edition: Balandin, R.K. (1979). *Vernadsky: Life, Ideas, Eternity*. Moscow.

Now I somehow feel clearly that what I am doing with my geochemistry and living matter is valuable and big. And I am ready to state it bluntly: I am sure that if our time fails to appreciate it, posterity will not... I began to perceive clearly that I was fated to tell mankind something new about the teaching of living matter that I have developed, and that is my destiny... Now I see that this teaching may have the same effect as Darwin's book...

However, Vernadsky observed that the rate of growth of scientific knowledge in his time was accelerating rather quickly. He repeatedly reflected upon this aspect of 20<sup>th</sup> century history and saw it as a unique “scientific revolution.” Indeed, Bernal later named this specific historical period the scientific-technical revolution (STR), the beginning of which he associated with the outbreak of World War II (Bernal, 1957, 1965; quoted in Teich, 1986). Observing the extremely rapid and intense development of science and participating directly in it himself (i.e. contributing to the 20<sup>th</sup>-century scientific-technical revolution), Vernadsky might have thought that his ideas would fall onto fertile soil and grow to be recognized and appreciated rapidly, perhaps even in his lifetime.

In this context, there is an interesting episode described by Lev Gumilevsky (1988) in his book about Vernadsky. Once, when in conversation with academician<sup>36</sup> Lev Semenovich Berg<sup>37</sup>, Vernadsky observed with a sad smile, that his “biosphere” has been

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<sup>36</sup> Academician – traditionally, the highest rank of honorary membership in the Russian Academy of Sciences, which usually has been awarded to relatively elderly scholars, through a very rigid process of candidate selection and election, for outstanding achievements in the advancement of science. Only a few would be able to receive this highest title of honor in their relatively “young” academic age, like it was with a 42-years old Vernadsky when he was elected a member of the Russian Imperial Academy of Science which was still in Tsarist Russia.

<sup>37</sup> Berg, Lev Semenovich (1876-1950) is “outstanding Russian geographer, biologist, and naturalist. His more than seven hundred publications, including several dozen books, explored subjects ranging from biogeography, evolutionary theory and taxonomy, to limnology, climatology, soils and the history of geography – and to all these studies he is one of the most important contributors. Berg's writings on regional geography are probably his most important overall--and especially those leading to his system of natural regions classification (as described in the most influential of his writings that was translated into English, *Natural Regions of the U. S. S. R.*)” (<http://people.wku.edu/charles.smith/chronob/BERG1876.htm>, retrieved on February 28, 2010). “Among his pioneering monographs on climatology were ‘Climate and Life’ (1922) and ‘Foundations of Climatology’ (1928). In the West, Berg is best known as the author of the

forgotten. Berg's responded succinctly: "You're making a mistake! It has become a classic. Many of its ideas have become deeply a part of [scientific] life, a particular representation of the world. It has taken on life of its own!"<sup>38</sup> (Gumilevsky, 1988).

It is necessary to know Vernadsky's character to understand that in the above example his concern was not about the word "my", i.e. authorship of the biosphere concept, but about the recognition/(reception and diffusion) of the biosphere concept as a new paradigm and worldview – i.e. about the "scientific truth" which was always his foremost professional concern. Here, as ever, Vernadsky was concerned primarily with the scientific life of his ideas. So long as his ideas advanced scientific truth he was less concerned for his own personal prestige as their author

As to the authority of the new ideas he was generating so productively, it was not unusual for him to assign authorship of his own ideas to his immediate students and collaborators. At the same time, Vernadsky was always extremely careful and scrupulous (sometimes even too scrupulous, according to some historians of science) in giving credit to all those that somehow contributed to or elaborated on the questions he formulated. The question of ethics in scholarship and research is a real concern in the modern world, and Vernadsky's positive example as a great role model also could be successfully used in the classroom and among young researchers.

Vernadsky's integrative and harmonious personality and character shines through his writing. Early in his life, at the age of 21, Vernadsky wrote in his diary a set of his life's goals; among others, as his priorities were:

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controversial macroevolution theory of Nomogenesis. Berg's name is featured in the Latin appellations of more than 60 species of plants and animals" (Wikipedia, 2009 – retrieved on February 28, 2010).

<sup>38</sup> Translated from the Russian by Elizabeth Ransome Stine.

1. Shaping the character. Especially important are: frankness, courage, to state and defend one's opinion, rejection of false shame, courage to follow one's views to the end, independence...
2. Education of intellect: (a) philosophy, (b) mathematics, music, arts.

In all respects, he lived his life in accordance with his ideals. He really was a representative of a human being that is doing what he is saying.

Marco Bischof (2005, p. 285) observes that

In his "Philosophical Thoughts of a Naturalist" (1988) he writes that the transition to the noosphere presupposes "the community of all humanity, of humans of brethren. Throughout Vernadsky's work, one can clearly trace the author's interest in the 'comradely, brotherly element in scientific organizations of the past and the present' which according to Vernadsky pave the way to the noosphere (Vernadsky, 1927). In Vernadsky's view, brotherhood should become the principle of relations between scholars and subsequently between all people on earth.

Thus, one more pedagogical outcome of familiarizing people with Vernadsky his high standing as a human in all terms, i.e. in personal, professional, and social life. He was a great personal example for his students, colleagues, and followers. Alexander Fersman, the closest pupil of Vladimir Vernadsky and his successor in the area of the development of geochemistry, wrote about Vernadsky (quoted in Yanshin, 2007):

His general ideas will be studied and elaborated during centuries and one will discover new pages in his works which will serve as the source for new searches. Many scientists will learn his creative thought which is acute, stubborn and articulated, always genial, but sometimes poorly understood. As for young generations, he always will be a teacher in science and a striking example of a fruitfully lived life.

Vernadsky's niece, Anna S. Krylenko, who was especially close to him after she lost her mother (Vernadsky's sister) and came to live in his family, wrote in her 1911-letter to him (quoted in Bailes, 1990, p. 129): "You amazed me in many respects,

especially your harmonious personality: an excellent scientist and a man with a sensitive social conscience, a specialist and a broad philosopher. You are not only a visionary but a practical man who gets things done and beloved by people.”

All people know that it is difficult to overestimate the tremendous effect of their favorite teachers on their life. Therefore, I believe that contemporary trends in education to substitute live teachers with digital courses or distance learning would not help much to overcome the global crisis, which is in fact, as shown in the first chapter, a crisis of our values and spirituality. Creatures like humans used to copy or imitate what they see, hear, and observe. Therefore, if they do not have a good live example before their eyes, they will follow the worse one.

Indeed, in the present age of technological progress, some people already question even the necessity for the live communication with teachers during the process of education that could be transformed technologically relatively soon into a pure virtual reality. David Orr argues that the role of a real teacher is irreplaceable and indispensable: “Academic fundamentalists “have mistaken the relationship between passion, emotion, and good science” (Orr, 1994, p. 44) and teaching that is always “flooded by emotion, especially the emotions of humility, reverence, mystery, wonder, and awe” (Maslow, p. 44: quoted by Orr, 1994, p. 44), and of course, includes a good sense of humor.

Orr calls the intension “to replace great many teachers with great deal of technology” into question: “What is known about the relative effects on young people of machines as opposed to caring, well-prepared, and devoted teachers?” (Orr, 1994, p. 38). In general favorite teachers were always open, sincere, passionate, enthusiastic, and committed people. The same features apply to the best respected and favorite teachers

and people I have met in my life. They all were generous givers. While in the Graduate School at UNH, I was lucky enough to enrich my collection of favorite teachers substantially. And Vladimir Ivanovich Vernadsky is also one of my favorite teachers now.

Although some people are skeptical about the current situation of society and environment, recent historical developments point out that humanity is actually progressing. Of course, because of our short lifespan, we cannot see the changes that are currently taking place. But progress or at least a positive shift is obvious in such dimensions as process of disarmament, struggle for peace, preventing nuclear war, formation of the European Union, international space programs, international environmental agreements and ecological movements, etc. However, more and more efforts are needed to reach people's consciousness to involve them in these processes.

As it was shown in present research, the need to popularize Vernadsky's concept of the noosphere for the formation a new, global and holistic worldview among people, and especially younger generations, is hardly disputable. This could and should be a powerful tool to resisting such fundamental contemporary phenomena as individualism and consumerism, growthism and economism, to which our society is addicted. All components of human nature such as our mind (through appropriate information and knowledge), heart (through feelings and emotions), and spirit (through highest human aspirations and morals) are supposed to be reached and moved in this process, thereby providing motivation to live and act properly. Family, school, and religious communities are called to play principal roles in cultivating a new worldview and attitude toward our common home, the planet Earth. The organized effort for overall ecological literacy on



national and international levels is needed for the implementation of a new worldview of the Earth, humanity, and our existence in the Universe. Ecological and sustainability literacy must become a mandatory part of education in elementary schools, middle schools, and high schools; a requirement in institutions of higher education (colleges and universities, technical - schools, community colleges, junior colleges); it also should involve mass media (especially television, magazines, and the internet) as a part of a national program and international programs. Vernadsky's theoretical system, as shown in this study, represents a conceptual framework for all kinds of these important educational activities.

I wonder how our descendants in 100 years will see our time and history of the 20<sup>th</sup> and 21<sup>st</sup> centuries. Probably, from that position in time and space, they will clearly see Vernadsky as one of the most beautiful and advanced minds of his time, who was far ahead of his contemporaries. Perhaps, he will be seen as a messenger with a mission to bring a new level of thinking and a new vision of the world, preparing people for a change on a global scale – for, perhaps, the most important transition to affect our civilization. Perhaps, in time, it will be seen that once the majority had been prepared for this shift, the conceptual scientific paradigm and philosophical framework ingeniously sketched by Vernadsky in his theoretical system, was recognized and understood as providing a full model of the process already in motion.

In all eras of human history, there were always the most advanced and beautiful minds that were striving to help people move to the next level of an evolutionary leap of consciousness. They are extraordinary people, who continue to affect the path of humanity, its cultural, scientific, and moral evolution profoundly, even though they have

passed away. These names are on everybody's lips, and they are referred to as if they are our contemporaries because of their unique capacity to be ahead of their own time. They continue to send their light of knowledge, inspiration, and hope like the bright stars in the night sky, which in fact went out millions or billions of years ago. The thinkers of this kind serve as the leading lights for the progress of humanity. Among these exclusive personalities there are, for example, Plato and Aristotle from ancient times, Leonardo da Vinci and Giordano Bruno from the Renaissance, Galileo Galilei and Johannes Kepler, Isaac Newton and Michail Vasilyevich Lomonosov, Charles Darwin and Albert Einstein, Leo Tolstoy and Mahatma Gandhi from the most recent history of humanity. Vladimir Ivanovich Vernadsky, the founder of the concept of the biosphere and the noosphere – the most progressive contemporary scientific and philosophical worldview – is certainly one of these exceptional thinkers who leaves indelible marks in human history and will affect the future evolution of humanity for a long time.

## REFERENCES

- Abraham, R. (2009). Geochemistry and the biosphere: Essays by Vladimir I. Vernadsky [Review of essays of Vernadsky]. *World Futures*, 65(5), 436-441. Retrieved February 27, 2010, from <http://www.ralph-abraham.org/reviews/vernadsky.pdf>
- Affluenza* [Motion picture]. (1997). Boe, V. & de Graaf, J. (Producers) & Ferrara, A. (Director). Oley, PA: Bullfrog Films, Inc.
- Aksenov G.P. (1993). Biography. In G.P. Aksenov (Ed.), *Vladimir Vernadsky: Biography. Selected works. Reminiscences of contemporaries. Opinions of descendants* (pp. 15-202). Moscow: Sovremennik (in Russian).
- Allen, J. (1990). Historical overview of the Biosphere 2 project. *Biological life support systems: Commercial opportunities NASA conference publication #3094*. Retrieved February 1, 2010, from <http://www.biospheres.com/pubhistoricaloverview.html>
- Allen, J. (2000). Noospherics, the discipline of intelligence concerning the biosphere. *Institute of Ecotechnics Conference*, France, Oct. 2000.
- Allen, J. (2009). *Me and the biospheres: A memoir by the inventor of Biosphere 2*. Santa Fe, NM: Synergetic Press.
- Andersen, V., & Johnson, L. (1997). *Systems thinking basics: From concepts to casual loops*. Waltham, Massachusetts: Pegasus Communications.
- Arbatov, A., & Bolshakov, B. (1987). Peace and the noosphere: The issues and development prospects. In S.A. Bolshakova (Ed.), *The environment and peace on earth* (65-83). Moscow: Nauka Publishers (in Russian).
- Architecture 2030*. Retrieved from <http://www.architecture2030.org>
- Arguelles, J.A (2010). *Planetary whole system design science: A contribution to World Shift 2012*. Retrieved February 5, 2010, from <http://www.lawoftime.org/planetarywholesystem.html>
- Axiom. (2010). In *Dictionary.com*. Retrieved March 20, 2010, from <http://dictionary.reference.com>
- Bailes, K.E. (1990). *Science and Russian culture in an age of revolutions: V.I. Vernadsky and his scientific school, 1963-1945*. Bloomington and Indianapolis, Indiana: Indiana University Press.
- Balandin, R.K. (1979). *Vernadsky: Life, ideas, eternity*. Moscow, Russia: Znaniye (in Russian).

- Balandin, R.K. (1982). *Vladimir Vernadsky*. Outstanding Soviet Scientists Series. (A. Repyev, Trans.). Moscow, Russia: Mir Publishers.
- Balandin, R.K. (1988). *Vernadsky: Life, ideas, eternity* (2<sup>nd</sup> ed.). Moscow, Russia: Znaniye (in Russian).
- Balandin, R. K. (n.d.) *Vladimir Vernadsky: Two ways of synthesizing the universe*. Retrieved February 3, 2010, from <http://www.synergeticpress.com/vernadsky%20PDFs/4%20Balandin.pdf>
- Behrends, T. (2005). The renaissance of V.I. Vernadsky. *Newsletter of the geochemical society*, 125, 8-14. Retrieved January 17, 2010, from <http://www.geochemsoc.org/downloads/gn125.pdf>
- Berry, W. (1995). *Another turn of the crank*. Washington, DC: Counterpoint.
- Bhagwati, J. (2004). *In defense of globalization*. Oxford, New York: Oxford University Press.
- Biospherics* (2010). Retrieved on March 14, 2010, from <http://www.synergeticpress.com/biospherics.html>
- Biospherics and closed systems*. (2006). Retrieved February 24, 2010, from <http://www.biospherefoundation.org/closedsystems.htm>
- Brockelman P. (1997). With new eyes: Seeing the environment as a spiritual issue. In J. E. Carroll, P. Brockelman & M. Westfall (Eds.), *The Greening of Faith* (pp. 30-43). Hanover, NH: University Press of New England.
- Brown, L.R. (2008). *Plan B 3.0: Mobilizing to save civilization*. New York, NY: W.W. Norton & Company.
- Campaign for Environmental Literacy. (2009). *New environmental literacy study ranks U.S. students below most other countries*. Retrieved April 25, 2009, from <http://fundee.typepad.com/fundee/2009/04/new-environmental-literacy-study-ranks-us-students-below-most-other-countries.html?cid=6a00e5538524f0883301310fb85c8e970c>
- Cancela da Fonseca, J.P. (2000). On Vernadsky's biosphere. *Web Ecology*, 1, 86-96. Retrieved March 10, 2010, from [http://www.oikos.ekol.lu.se/pub/we/Web\\_Ecol.1.86-96.pdf](http://www.oikos.ekol.lu.se/pub/we/Web_Ecol.1.86-96.pdf)
- Capra, F. (1999). *Ecoliteracy: The challenge for education in the next century*. California: Center for Ecoliteracy.

- Carroll, J. E. (2004). *Sustainability and spirituality*. New York, NY: State University of New York Press.
- Carroll, J. E., Brockelman, P., & Westfall, M. (Eds.). (1997). *The greening of faith*. Hanover, NH: University Press of New England.
- Carson, R. (1962). *Silent Spring*. Boston, MA: Houghton Mifflin.
- Chekhov, A. (1897), *Uncle Vanya*.
- Clark, W.C. (2007), Sustainability science: A room of its own. *Proceedings of the National Academy of Sciences*, 104(6): 1737-1738.
- Clark, W. C., Crutzen, P. J., & Schellnhuber, H. J. (2004). Science for global sustainability: Toward a new paradigm. In H. J. Schellnhuber, P. J. Crutzen, W. C. Clark, M. Claussen & H. Held (Eds.), *Earth system analysis for sustainability* (1-28). Cambridge, MA: MIT Press.
- CNNPolitics.com. (2009, January 29). *Obama blasts bonuses for struggling Wall Street*. Retrieved February 11, 2009, from <http://politicalticker.blogs.cnn.com/2009/01/29/obama-blasts-bonuses-for-struggling-wall-street/>
- Croucher, S.L. (2004). *Globalization and belonging: The politics of identity in a changing world*. Lanham, Maryland: Rowman & Littlefield.
- Culture. (n.d.) In *English Wikipedia*. Retrieved 24 July, 2004, from <http://july.fixedreference.org/en/20040724/wikipedia/Culture>
- Darwin, C. (1971). *The descent of man and selection in relation to sex*. London: J. Murray.
- Dioum B. (1968). In B.K. Rodes & R. Odell (Eds.), *Dictionary of environmental quotations*. Baltimore, Maryland: Johns Hopkins University Press.
- Ede, S. (2002). *Do we fit on the planet? Food systems and the ecological footprint*. Retrieved February 25, 2009, from, <http://www.urbanecology.org.au/articles/dowefit.html>
- Edwards, A. R. (2005). *The sustainability revolution: Portrait of a paradigm shift*. Gabriola Island, Canada: New Society Publishers.
- Einstein, A. (1952). *Letter to Beatrice Frohlich, December 17, 1952*; Einstein Archive 59-797. Retrieved March 31, 2010, from [http://4brightminds.info/einstein\\_short\\_quotes.htm](http://4brightminds.info/einstein_short_quotes.htm)

- Ellis, E., & Bledzki, L.A. (2009). Biosphere. In: C.J. Cleveland (Ed.), *Encyclopedia of Earth*. Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment. Retrieved February 27, 2010, from <http://www.eoearth.org/article/Biosphere>
- Encyclopedia of Ecology*. (2010). Retrieved March 9, 2010, from <http://www.elsevierdirect.com/brochures/ecology/index.html>
- Engel, J. R. (1990). Introduction. In J.R. Engel and K.G. Engel (Eds.), *Ethics of environment and development: Global challenge, international response*. Tucson, AZ: The University of Arizona Press.
- Fersman, A. E. (1946). The life of the academician Vladimir Ivanovich Vernadsky (1863-1945). *Papers of the Russian Mineralogical Society*, 75 (1): 5-24 (in Russian).
- Foster, J. B. (1999). Global ecology and the common good. *Cultural Logic*, 3 (1). Retrieved June 3, 2004, from <http://clogic.eserver.org/3-1&2/foster.html>
- Gaia. (2010). *Wikipedia*. Retrieved March 20, 2010, from <http://en.wikipedia.org/wiki/Biosphere>
- Galactic Research Institute. (2006). *It is not a biospheric crisis, but a noospheric emergency – envisioning the regeneration of planet Earth*. Retrieved February 5, 2010, from <http://www.lawoftime.org/noosphere/nooarticles/noosphericemergency.html>
- Generalist. (2010). In *Dictionary.com*. Retrieved February 4, 2010, from <http://dictionary.reference.com/browse/generalist>
- Ghilarov, A. M. (1995). Vernadsky's biosphere concept: An historical perspective. *Quarterly Review of Biology* 70: 193-203.
- Global Footprint Network. (2008, 29 October). *Earth overshoot day 2009*. Retrieved February 22, 2009, from [http://www.footprintnetwork.org/en/index.php/GFN/page/earth\\_overshoot\\_day/](http://www.footprintnetwork.org/en/index.php/GFN/page/earth_overshoot_day/)
- González, P. (1995). An eco-prophetic parish? In A.J. LaChance & J.E. Carroll (Eds.), *Embracing earth: Catholic approaches to ecology* (pp. 214-224). New York, NY: Orbis Books.
- Goodland, R. (1995). The concept of environmental sustainability. *Annu. Rev. Ecol. Syst.*, 26: p. 1-24.
- Gore, A. (2006). *An inconvenient truth: The planetary emergency of global warming and what we can do about it*. Emmaus, PA: Rodale Press.

- Green, C. (2001). *Manufacturing powerlessness in the black diaspora: Inner-city youth and the new frontier*. New York: Altamira Press.
- Grinevald, J. (1996). *Sketch for a history of the idea of the biosphere*, P. Bunyard (Ed.). Edinburgh: Floris Books.
- Grinevald, J. (1998). Introduction: The invisibility of the Vernadskian revolution. In V.I. Vernadsky, *The Biosphere* (pp. 20-32). New York, NY: Copernicus Springer-Verlag.
- Grinevald, J. (1998a). Vladimir Ivanovich Vernadsky (1863-1945): A biographical chronology. In V.I. Vernadsky, *The Biosphere* (pp. 151-158). New York, NY: Copernicus Springer-Verlag.
- Guegamian, G.V. (2006). Living matter and biospherology. In A.A. Cigna & M. Durante (Eds.), *Radiation Risk estimates in Normal and Emergency Situations* (pp. 35-46). Dordrecht, Netherlands: Springer Netherlands. NATO Security through Science Series; Series B Physics and Biophysics 9.
- Gumilevsky, L. (1988). *Vernadsky*. Moscow, Russia: Molodaja Gvardija (in Russian).
- Halbrooks J. (2002). Value and the environment, *Ludvig von Mises Institute Articles*. Retrieved April 7, 2010, from <http://mises.org/daily/922>
- Hawken, P. (2008). *Blessed unrest: How the largest social movement in history is restoring grace, justice, and beauty to the world*. New York, NY: Penguin Books.
- Hutchinson, G.I. (1954). The biochemistry of the terrestrial atmosphere. In G.P. Kuiper (Ed.), *The solar system: The Earth as a planet* (pp. 371-433). Chicago, Illinois: The University of Chicago Press.
- Hutchinson, G.I. (1970). The biosphere. *Scientific American*, 223 (3): 45-53.
- Hutchinson, G.I. (1979). *The kindly fruits of the Earth: Recollections of an embryo ecologist*. New Haven: Yale University Press.
- Interdisciplinary. (2010). *Wikipedia Encyclopedia*. Retrieved February 3, 2010, from <http://en.wikipedia.org/wiki/Interdisciplinary>
- Intergovernmental Panel on Climate Change. (1988). Retrieved March 7, 2010, from <http://www.ipcc.ch>
- IPCC Assessment Reports 1990, 1995, 2001*. Retrieved on February 3, 2007, from <http://www.ipcc.ch>



- IPPC Summary Report (2007). Retrieved May 7, 2007, from [http://www.ipcc.ch/publications\\_and\\_data/ar4/wg1/en/spm.html](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/spm.html)
- Jäger, C. (2008). Noosphere. In S.E. Jørgensen & B.D. Fath (Eds.), *Encyclopedia of Ecology* (pp. 2533-2536). Oxford: Elsevier.
- Janas, M. (1988, September 17). Ancestry and influence: A portrait of David Orr. *News and Features*. Oberlin, OH: Oberlin College.
- Jusinski, C. (2009). *Reinventing the world*. Retrieved February 18, 2009, from [http://www.sfreporter.com/stories/reinventing\\_the\\_world/4451/all](http://www.sfreporter.com/stories/reinventing_the_world/4451/all)
- Kauffmann, G.B. (1991). Biosphere pioneer, *The World & I, October 1991*: 316-323.
- Kauffman, G.B. (1991). Vladimir Ivanovich Vernadsky: Biosphere pioneer. *The World & I, 10*: 316-323.
- Kaza, S. (1997). The gridlock of domination: A Buddhist response to environmental suffering. In J.E. Carroll, P. Brockelman & M. Westfall (Eds.), *The greening of faith* (pp. 141-157). Hanover, NH: University Press of New England.
- Kelly, T. (1999). The higher standards we need most. *High School, 4*: 4-7.
- Kelly, T.F. (2004). *The higher standards we need most*. Retrieved February 1, 2004, from <http://www.hi-ho.ne.jp/taku77/refer/kelly.htm>
- Kelly, T.H. (2005). *Where in the world is UNH? A university dialogue on globalization 2005-2006*. Retrieved February 3, 2009, from <http://www.unh.edu/academic-affairs/discovery/dialogue/2005/pdf/ud-05-06-complete.pdf>
- Kemmis, D. (1990). *Community and the politics of place*. Norman, OK: University of Oklahoma Press, Norman.
- Kormondy, E.J. (2007). Review [Review of book *Geochemistry and the biosphere*]. Retrieved February 3, 2010, from [http://www.amazon.com/gp/product/product-description/0907791360/ref=dp\\_prod-desc\\_0?ie=UTF8&n=283155&s=books](http://www.amazon.com/gp/product/product-description/0907791360/ref=dp_prod-desc_0?ie=UTF8&n=283155&s=books)
- Korsakova-Kreyn, M. (2009). Affective response to tonal modulation. (Doctoral Dissertation Thesis, University of Texas, 2009).
- Kosmin, B.A, Mayer, E., & Keyzar, A. (2001). American religious identification survey. New York, NY: The Graduate Center of the City University of New York.

- Retrieved February 3, 2007, from  
[http://www.gc.cuny.edu/faculty/research\\_briefs/aris.pdf](http://www.gc.cuny.edu/faculty/research_briefs/aris.pdf) &  
[http://www.adherents.com/rel\\_USA.html#2004total](http://www.adherents.com/rel_USA.html#2004total)
- Lapo, A.V. (1979). *Traces of bygone biospheres*. Moscow: Mir Publishers (in Russian).
- Lapo, A.V. (1988). *Traces of bygone biospheres*. Santa Fe, NM: Synergetic Press.
- Lapo, A.V. (2001). Vladimir I. Vernadsky (1863-1945), founder of the biosphere concept. *Int. Microbiol.* 4: 47-49.
- Lapo, A.V. (2002). Why to Paris? Report on the results of a business trip with indispensable comments. *Noosphere*, 14: 32-39.
- LaRouche, L.H. (2001). *The Economics of the noosphere*. Washington, DC: EIR News Service.
- LaRouche, L.H. (2005). The Vernadsky strategy. *Executive Intelligence Review*, February 18, 2005, 6-11. Retrieved February 3, 2010, from  
[http://www.larouchepub.com/eirtoc/2005/eirtoc\\_3207.htm](http://www.larouchepub.com/eirtoc/2005/eirtoc_3207.htm)
- Lash, J. L. (2006). *Not in his image: Gnostic vision, sacred ecology, and the future of belief*. White River Junction, Vermont: Chelsea Green Publishing Company.
- Layzer, J. A. (2006). *The environmental case: Translating Values into Policy*. Washington, D.C.: QC Press.
- Le Roy, E. (1927). *L'Exigence idealiste et le fait de l'évolution*. Paris, France: Boivin (in French).
- Le Roy, E. (1928). *Les Origines humaines et l'évolution de l'intelligence*. Paris, France: Boivin (in French).
- Leonard, A. (2008). *The opportunity in this time of crisis*. Retrieved February 23, 2009, from <http://www.storyofstuff.com/blog/?p=20>
- Levit G.S. (2001). *Biochemistry–biosphere–noosphere: The growth of the theoretical system of Vladimir Ivanovich Vernadsky*. Berlin: VWB-Verlag für Wissenschaft und Bildung.
- Levit G.S., Hossfeld, U., & Olsson, L. (2006). From the “modern synthesis” to cybernetics: Ivan Ivanovich Schmalhausen (1884-1963) and his research program for a synthesis of evolutionary and developmental biology. Retrieved 27, 2010, from <http://www3.interscience.wiley.com/cgi-bin/fulltext/112249386/PDFSTART>

- Limnology. (2010). *Biology online*. Retrieved February 14, 2010, from <http://www.biology-online.org/dictionary/Limnology>
- Livingstone, G.G. (2005). *PaGaian cosmology: Re-inventing Earth-based goddess religion*. Retrieved February 3, 2010, from <http://pagaian.org/book>
- Lobanova, Z.M. (2002). Ecological education at Technical University: Goals, problems, and some ways of their resolution. *Horizons of Education*, 4: 1-9 (in Russian).
- Lovelock, J.E. (1979). *Gaia: A new look at life on earth*. New York, NY: Oxford University Press.
- Lovelock, J.E. (1988). *The ages of Gaia: A biography of our living Earth*. New York, NY: Norton.
- Lugalla, J. L.P. (2005). *Where in the World is UNH? A University Dialogue on Globalization 2005-2006* (pp. 46-46). Retrieved February 3, 2009, from <http://www.unh.edu/academic-affairs/discovery/dialogue/2005/pdf/ud-05-06-complete.pdf>
- MAB. (2010). *Man and the biosphere programme*. Retrieved March 20, 2010, from [http://en.wikipedia.org/wiki/Man\\_and\\_the\\_Biosphere\\_Programme](http://en.wikipedia.org/wiki/Man_and_the_Biosphere_Programme)
- Mandelker, A. (1994). Semiotizing the sphere: Organicist theory in Lotman, Bakhtin, and Vernadsky. *The Modern Language Association of America, PMLA*, 109 (3): 385-396.
- Margulis, L. (1996). James Lovelock's Gaia. In: P. Bunyard (Ed.), *Gaia in action* (pp. 54-65). Edinburgh, United Kingdom: Floris Books.
- Margulis, L., & Sagan, D. (2003). *Acquiring genomes: A theory of the origins of species*. New York, NY: Basic Books.
- Margulis, L., Ceruti, M., Golubic, S., Guerrero, R., Ikeda, N., Ikezawa, N., Krumbein, W. E., Lapo, A., Lazcano, A., Suzuki, D., Tickell, C., Walte, M., & Westbroek, P. (1988). Foreword to the English-Language Edition. In V.I. Vernadsky, *The Biosphere* (pp.14-19). New York, NY: Copernicus Springer-Verlag.
- Masani, P.R. (2005). The ecology of the noosphere: where the ecological movement falls short. *Kybernetes*, 24 (9): 13-34.
- McDaniel, J. (1997). The sacred whole: An ecumenical Protestant approach. In J.E. Carroll, P. Brockelman & M. Westfall (Eds.), *The greening of faith* (pp. 105-124). Hanover, NH: University Press of New England.

- Meadows, D.H., Meadows, D., & Randers, J. (1992). *Beyond the limits: Confronting global collapse, envisioning a sustainable future*. Post Mills, Vermont: Chelsea Green.
- Meadows, D. (1998). *Indicators and information systems for sustainable development: A report to the Balaton group*. Hartland, Vermont: The Sustainability Institute.
- Meadows, D. (1999) *Leverage points: Places to intervene in a system*. Retrieved February 3, 2010, from [http://www.sustainer.org/pubs/Leverage\\_Points.pdf](http://www.sustainer.org/pubs/Leverage_Points.pdf)
- Meadows, D., Randers, J., & Meadows, D. (2004), *Limits to growth: The 30-year Update*. White River Junction, Vermont: Chelsea Green.
- Meadows, D. (2008). *Thinking in systems*. White River Junction, Vermont: Chelsea Green Publishing.
- Merkel, J. (2003). *Radical simplicity: Small footprints on a finite Earth*. Gabriola Island, Canada: New Society Publishers.
- Mikulinskij, S. (1989). About the essence and origin of the noosphere teaching of V.I. Vernadsky. In: A.L. Yanshin (Ed.), *Scientific and social significance of Vernadsky's creativity* (pp. 98-107). Moscow, Russia; Nauka (in Russian).
- Mochalov I.I. (1988). V.I. Vernadsky and religion. *Questions of Natural History and Technique*, 2: 36-44.
- Naumov, G.B. (2005). From the fact to empirical generalization and scientific explanation (Methodology of V.I. Vernadsky). *Lithology & Mineral Resources*, 4 (1): 1-8.
- NCES. (2007). *Highlights from PISA 2006: Performance of U.S. 15-year-old students in science and mathematics literacy in an international context*. Retrieved February 3, 2010, from <http://nces.ed.gov/pubs2008/2008016.pdf>
- NGIVF. (2010). *The non-governmental ecological Vernadsky foundation*. Retrieved March 31, 2010, from [http://www.vernadsky.ru/eng/Partners\\_view.php](http://www.vernadsky.ru/eng/Partners_view.php)
- Oxford English Dictionary. (2010). Retrieved from <http://dictionary.oed.com/entrance.dtl>
- Oderberg, I.M. (1998). Earth – the biosphere. *Sunrise*, August/September 1998, Theosophical University Press. Retrieved on February 27, 2010, from <http://www.theosophy-nw.org/theosnw/science/sc-imo7.htm>
- Odum, E.P. (1971). *Fundamentals of ecology*. Philadelphia, PA: Saunders.

- Odum, E.P. (1989). *Ecology and our endangered life-support systems*. Sunderland, MA: Sinauer Associates, Inc., Publishers.
- Oldfield, J. (2001). Russia, systematic transformation and the concept of sustainable development. *Environmental Politics*, 10 (3), 94-110.
- Oldfield, J. D. & Shaw, D. J. B. (2002). Revisiting sustainable development: Russian cultural and scientific traditions and the concept of sustainable development. *Area* 34 (4), 391-400.
- Oldfield, J. D., Kouzmina, A., & Shaw, D. J. B. (2003). Russia's involvement in the international environmental process: A research report. *Eurasian Geography and Economics* 44 (2), 157-168.
- Oldfield, J.D. and Shaw, D.J.B. (2006). V.I. Vernadsky and the noosphere concept: Russian understandings of society-nature interaction. *Geoforum*, 37, 145-154.
- Obama action due on executive pay. (4 February 2009). *BBC News*. Retrieved February 11, 2009, from <http://news.bbc.co.uk/2/hi/business/7870632.stm>
- Orr, D.W. (1989). Ecological literacy: Education for the twenty-first century. *Holistic Education Review*, fall 1989, 48-53.
- Orr, D.W. (1991). What is Education for? *In Context* 27, page 52.
- Orr, D.W. (1992). *Ecological literacy: Education and the transition to a postmodern world*. Albany, New York: State University of New York Press.
- Orr, D.W. (1994). *Earth in mind: On education, environment, and the human prospect*. Washington, DC: Island Press, 1994.
- Orr, D. (2005). Foreword, In: A.R. Edwards, *The sustainability revolution: Portrait of a paradigm shift*, New Society Publishers.
- Ozhegov, S.I., & Shvedova, N.U. (1999). *Explanatory dictionary of the Russian language*. Moscow, Russia: Azbukovnik (in Russian).
- Perkins, J. (2007). *The secret story of the American empire*. NY, NY: Dutton.
- Piqueras, M. (1998). Meeting the Biospheres: on the translations of Vernadsky's work. *Internatl. Microbiol.* 1, 165-170.
- PISA. (2006). The OECD Programme for International Student Assessment (PISA). The New Environmental Literacy Study. Retrieved April 25, 2009, from

[http://www.oecd.org/document/22/0,3343,en\\_32252351\\_32236191\\_42466966\\_1\\_1\\_1\\_1,00.html](http://www.oecd.org/document/22/0,3343,en_32252351_32236191_42466966_1_1_1_1,00.html)

Pitman, A.J. (2005). On the role of geography in earth system science. *Geoforum* 36 (2), 137-148.

Polunin, N. (1980). Environmental education and the biosphere. *Environmental Conservation* 7 (2), 89-90.

Prescott-Allen, R. (1992). Caring for the world. In C. Rockefeller & J.C. Elder (Eds.), *Spirit and nature* (pp. 125-138). Boston, MA: Beacon Press.

Pyatibratova T.B. (2000). The prominent Russian scientist V.I. Vernadsky. Retrieved on February 25, 2009, from <http://en.tstu.ru/tambov/kultur/nauka/vernad/uchver.htm>

Report on “*The development of the system of ecological education in Russian Federation in 1992-2002*”, Part 1 (pp. 9-12). Retrieved from [http://www.mnr.gov.ru/files/part/7269\\_5.doc](http://www.mnr.gov.ru/files/part/7269_5.doc) (in Russian).

Rezvykh, P. (2004). George S. Levit: *Biogeochemistry–biosphere–noosphere: The growth of the theoretical system of Vladimir Ivanovich Vernadsky*. *HYLE--International Journal for Philosophy of Chemistry* 10 (1), 61-62, [http://www.hyle.org/journal/issues/10-1/rev\\_rezvykh.htm](http://www.hyle.org/journal/issues/10-1/rev_rezvykh.htm), retrieved on March 10, 2010.

Rifkin, J (1991). *Biosphere politics: A new consciousness for a new century*. New York, New York: Crown Publishers, Inc.

Robbins, L. (2003). Happiness: Has social science a clue? Lionel Robbins Memorial Lectures, London School of Economics, Delivered 3-5 March, 2003.

Rockefeller, S.C. (1997). The wisdom of reverence for life. In J.E. Carroll, P. Brockelman & M. Westfall (Eds.), *The greening of faith* (pp. 44-61). Hanover, NH: University Press of New England.

Rockefeller, S.C. & Elder, J.C. (Eds.). (1992). *Spirit and nature*. Boston, MA: Beacon Press.

Rowe, J. S. (1996). From shallow to deep ecological philosophy, *The Trumpeter*, 13 (1), 26-31.

Rowland, S.M. (1993). Review of *Science and Russian Culture in an Age of Revolution* by Kendall E. Bailes, *Earth Sciences History* 12, 245-247.

- Sahtouris, E. (2000). *Earthdance: Living systems in evolution*. Lincoln, NE: iUniversity Press. Also available at <http://www.ratical.org/LifeWeb/Erthdnce/erthdnce.pdf>.
- Sahtouris, E. (2002). What's wrong with environmental education? Tachi Kiuch's Tokyo Newsletter, *The Bridge*, March 2002.
- Salisbury, F.B. (2007). Editor's forward. In *Geochemistry and the biosphere: Essays by Vladimir I. Vernadsky*. F.B. Salisbury (Ed.). First English Translation from the 1967 Russian Edition of *Selected Works*. Santa Fe, NM: Synergetic Press, p. i-xv.
- Samson, P.R. & Ritt, D. (1999). *The biosphere and noosphere reader*. New York, NY: Routledge.
- Shaping a Sustainable Future: The IUCN Programme 2009-2012, (2008), 5-14 October, 2008, Retrieved February 19, 2009 from [http://cmsdata.iucn.org/downloads/iucn\\_programme\\_2009\\_2012\\_dfc.pdf](http://cmsdata.iucn.org/downloads/iucn_programme_2009_2012_dfc.pdf)
- Shelekhov, A. M. (Ed.). (2002). *Basic statements of Russia's transition to sustainable development*. Moscow, Russia: The State Duma [Russian Parliament] (in Russian).
- Smil, V. (2002). *The Earth's biosphere: Evolution, dynamics and change*. Cambridge, Massachusetts: The MIT Press.
- Smith, O. (2009). Towards an ecology of history: Russian sophiology and cosmism on the future. In L. Andrianos, K. Kenanidis, & A. Papaderos (Eds.). *ECOTHEE: Ecological Theology and Environmental Ethics* (pp. 461-482). Proceedings of the First International Interdisciplinary Conference on Ecological Theology and Environmental Ethics. Chania, Greece: Orthodox Academy of Crete Publications.
- Snyder, D.P. (2010). *Geochemistry & the biosphere: Essays by Vladimir Vernadsky*. Retrieved March 7, 2010, from <http://www.synergeticpress.com/biospherics.html>
- Sobornost'. (2010). Retrieved March 3, 2010, from Wikipedia Online Encyclopedia: <http://en.wikipedia.org/wiki/Sobornost>
- Spannaus, N. (2005). Using the Vernadsky principle to save the world economy. *Executive Intelligence Review*, February 18, 2005, 4-5. Retrieved February 3, 2010, from [http://www.larouchepub.com/eirtoc/2005/eirtoc\\_3207.htm](http://www.larouchepub.com/eirtoc/2005/eirtoc_3207.htm)
- Spirit and nature*. (1992). S.C. Rockefeller & J.C. Elder (Eds.). Boston, Massachusetts: Beacon Press.
- Statement of Dr. James Hansen, Director, NASA Goddard Institute for Space Studies,

- Greenhouse effect and Global Climate Change, Hearing before the Committee of Energy and Natural Resources, U.S. Senate, 100<sup>th</sup> Cong., 1<sup>st</sup> sess., on the Greenhouse Effect and Global Climate Change, Part 2, (June 23, 1988).
- Subetto, A.I. (2003), Noospherism and Vernadskian revolution. *Academy of Trinitarism*, M., El. No. 77-65-67, publ. 10355, April 23, 2003, Retrieved March 28, 2006, from <http://www.trinitas.ru/rus/doc/0203/001a/02030005.htm> (in Russian).
- Suess, E. (1875). *Die Entstehung der Alpen (The Origin of Alps)*, Vienna: W. Braunmüller.
- Summary for Policymakers: A Report of Working Group 1 of the Intergovernmental Panel on Climate Change. February 7, 2007, <http://www.ipcc.ch/SPM2feb07.pdf>
- Summary (2004). Summary of The Institute of Ecotechnics 2004 Conference “The Noosphere: Art, Science and Ventures,” October 22-25, 2004, Les Marronniers Conference Centre, Aix-en-Provence, France. Retrieved February 18, 2010, from <http://www.ecotechnics.edu/2004summary.html>
- Svirezhev, Y. M. (1998). Globalistics: A new synthesis philosophy of global modelling. *Ecological Modelling* 108 (1-3): 53–65.
- Svirezhev, Y.M., & Svirejva-Hopkins, A. (2008). Biosphere: Vernadsky’s concept. Noosphere. In S.E. Jørgensen & B.D. Fath (Eds.), *Encyclopedia of Ecology* (pp. 467-471). Oxford: Elsevier.
- Swan, J. (1995). Nature as teacher and healer: How to reawaken your connection with nature. In Chiras, D.D. (Ed.), *Voices for the Earth: Vital ideas from America’s best environmental writers* (pp. 170-194). Boulder, CO: Johnson Books.
- Synergetic Press. (2007). Biospherics. Retrieved February 21, 2010, from <http://www.synergeticpress.com/biospherics.html>,
- Sytnik, K., Apanovich, E., & Stoiko, S. (1988). *V.I. Vernadsky. Life and activity in the Ukraine*. Kiev, Ukraine: Naukova Dumka (in Russian).
- Teich, M. (1986). The scientific-technical revolution: An historical event in the 20<sup>th</sup> century? In R. Porter and M. Teich (Eds.). *Revolution in history*. New York, NY: Cambridge University Press, 317-330.
- Tennenbaum, J. (2005). Eurasian infrastructure and the noosphere. *Executive Intelligence Review*, February 18, 2005, 12-18. Retrieved February 3, 2010, from [http://www.larouchepub.com/eirtoc/2005/eirtoc\\_3207.htm](http://www.larouchepub.com/eirtoc/2005/eirtoc_3207.htm)



- Tennenbaum, J. (2005). Vernadsky and the future of biophysics. *Executive Intelligence Review*, February 18, 2005, 1922. Retrieved February 18, 2010, from [http://www.larouchepub.com/eirtoc/2005/eirtoc\\_3207.htm](http://www.larouchepub.com/eirtoc/2005/eirtoc_3207.htm)
- The 2010 Imperative, <http://www.2010imperative.org/index.html>.
- The End of Suburbia: Oil Depletion and the Collapse of The American Dream* [Motion picture]. (2004). Silverthorn, B. (Producer) & Greene, G. (Director). Toronto, Canada: Electric Wallpaper Co.
- The Free Dictionary. (2009). [thefreedictionary.com](http://www.thefreedictionary.com), Retrieved February 24, 2009, from <http://www.thefreedictionary.com/holistic+theory>.
- The Market Oracle (20 September, 2008). Institutional greed responsible for financial collapse. Retrieved February 11, 2009, from <http://www.marketoracle.co.uk/Article6360.html>
- The Prominent Russian Scientist V.I. Vernadsky (2010). Tambov State University. Retrieved March 5, 2010, from <http://www.tstu.ru/en/tambov/kultur/nauka/vernad/uchver.htm>
- Thomashow, M. (2002). *Bringing the biosphere home: Learning to perceive global environmental change*. Cambridge, Massachusetts: The MIT Press.
- Tolle, E. (2005), *A new earth: Awakening to your life's purpose*. New York, NY: Penguin.
- Trubetskova, I. (2004). Vladimir Ivanovich Vernadsky and his revolutionary theory of the biosphere and the noosphere. Retrieved February 3, 2010, from [http://www-ssg.sr.unh.edu/preceptorial/Summaries\\_2004/Vernadsky\\_Pap\\_ITru.html](http://www-ssg.sr.unh.edu/preceptorial/Summaries_2004/Vernadsky_Pap_ITru.html)
- Trubetskova, I. (2009). Global ecological crisis: A call for a new, ecological and holistic worldview. In L. Andrianos, K. Kenanidis, & A. Papaderos (Eds.), *ECOTHEE: Ecological theology and environmental ethics* (pp. 427-442). Chania, Greece: Orthodox Academy of Crete Publications.
- Ukaz. (1996). Concerning the Concept of Russia's Transition to Sustainable Development. *Rossiyskaya Gazeta*, April 9, 1996, page 5 (in Russian).
- UNESCO, 2005. United Nations Decade of Education for Sustainable Development (2005-2014): International Implementation Scheme. UNESCO, October, 2005.
- United Nations, (1987), Report of the World Commission on Environment and Development, General Assembly Resolution 42/187, 11 December 1987.

- UN. (1987). United Nations General Assembly (1987) *Report on the world Commission on Environment and Development: Our common Future*. Transmitted to the General Assembly as an Annex to document A/42/427 - Development and International Co-operation: Environment. Retrieved March 8, 2010, from <http://www.un-documents.net/wced-ocf.htm>
- UN. (1987a). United Nations General Assembly (March 20, 1987). *Report of the World Commission on Environment and Development: Our Common Future; Transmitted to the General Assembly as an Annex to document A/42/427 - Development and International Co-operation: Environment; Our Common Future, Chapter 2: Towards Sustainable Development; Paragraph 1*. United Nations General Assembly. Retrieved March 8, 2010, from <http://www.un-documents.net/ocf-02.htm>
- United Nations Development Programme. (2003). *Human Development Report 2003: Millennium Development Goals – A Compact Among Nations to End Poverty*. UNDP. New York, NY: Oxford University Press.
- van der Post, L. (1986). *A walk with a white bushman*. J-M. Pottiez (Ed.). New York: William Morrow & Co.
- Van Matre, Steve (1990). *Earth education: A new beginning*. Cedar Cove Greenville, West Virginia: the Institute for Earth Education.
- Van Matre, Steve (1995). Earth education: a new beginning. In D.D. Chiras (Ed.), *Voices for the Earth: Vital ideas from America's best environmental writers* (pp. 122-141). Boulder, CO: Johnson Books.
- VanDeVeer, D., & Pierce, C. (2003). *The environmental ethics and policy book: Philosophy, ecology, economics*. Belmont, California: Thomson & Wadsworth.
- Vernadsky, V.I. (1922). About scientific worldview. *Voprosy Filosofii i Psikhologii* 65, 1409 (in Russian).
- Vernadsky, V.I. (1923). A plea for the establishment of the biogeochemical laboratory. *The Marine Biol. Stat. of Port Erin. Ann. Rep.* 37, 38-43.
- Vernadsky, V.I. (1924). *La Géochimie*. Paris: Alcan (in French).
- Vernadsky, V.I. (1926). *Biosfera (The biosphere)*. Leningrad, Russia: Nauchnoe khimiko-technicheskoye izdatel'stvo, Scientific Chemico-Technical Publishing (in Russian).
- Vernadsky, V.I. (1927). *Essays on geochemistry*. Moscow, Russia: Gosizdat, (in Russian).

- Vernadsky, V.I. (1929). *La Biosphère*. Paris, France: Félix Alcan (in French)
- Vernadsky V. (1930). *Geochemie in Ausgewählten Kapiteln (Essays on geochemistry)*. Leipzig: Akad. Verlagsgesellsch (in German).
- Vernadsky, V.I. (1930). L'étude de la vie et la nouvelle physique. *Revue generale des Sciences* 41, 695-712 (in French).
- Vernadsky, V.I. (1940). *Biogeochemical essays 1922-1933*. Moscow-Leningrad (in Russian).
- Vernadsky, V.I. (1944). Problems of biochemistry II. *Transactions of the Connecticut Academy of Arts and Sciences* 35, 488-489.
- Vernadsky, V.I. (1944). A Few words about the noosphere. *The Successes of Biology (Uspehi Biologii)* 18 (2), 113-120 (in Russian).
- Vernadsky, V.I. (1944a). A few words on the noösphere. *Uspekhi sovremennoi biologii* 18 (2), 113-120 (in Russian).
- Vernadsky V.I. (1945). The biosphere and the noosphere, *Scientific American* 33 (1), 1-12.
- Vernadsky, V.I. (1965). *The chemical structure of the biosphere of the Earth and of its environment*. Moscow, Russia: Nauka (in Russian).
- Vernadsky, V.I. (1986). *The biosphere*. Abridged translation of Vernadsky, V.I., 1926, *The Biosphere* (in Russian). Oracle, AZ: Synergetic Press.
- Vernadsky, V.I. (1991). *Scientific thought as a planetary phenomenon*. Moscow: Nauka (in Russian).
- Vernadsky, V.I. (1997). *Scientific thought as a planetary phenomenon*. (B.A. Starostin, Trans.). Moscow, Russia: Nongovernmental Ecological V.I. Vernadsky Foundation.
- Vernadsky, V.I. (1998). *The Biosphere*. Full translation of Vernadsky, V.I., 1926, *The Biosphere*. New York, NY: Copernicus Springer-Verlag.
- Vernadsky, V.I. (2007). A few words about the noosphere. In V.I. Vernadsky. *Geochemistry and the biosphere: Essays by Vladimir I. Vernadsky* (pp. 405-417). F.B. Salisbury (Ed.). Santa Fe, NM: Synergetic Press.

- Vernadsky, V.I. (2007). *Geochemistry and the biosphere: Essays by Vladimir I. Vernadsky*. F.B. Salisbury (Ed.). First English Translation from the 1967 Russian Edition of *Selected Works*. Santa Fe, NM: Synergetic Press.
- Vinogradov, A.P. (1963). Development of V.I. Vernadsky's ideas. *Soviet Soil Science* 8: 727-732 (in Russian).
- Vinogradov, I.P (1963). The scientific legacy of V.I. Vernadsky. In N. Kaner & R. Amois (Eds.). Proceedings of the Geochemical Conference Commemorating the Centenary of Academician V.I. Vernadskii's Birth, Academy of Sciences of the USSR, V.U.I. Institute of Geochemistry and Analytical Chemistry. Jerusalem: Israel Program for Scientific Translations. Volume 1, 1-8.
- Volk, T. (2007). Back cover of *Geochemistry and the biosphere: Essays by Vladimir I. Vernadsky*. F.B. Salisbury (Ed.). First English Translation from the 1967 Russian Edition of *Selected Works*. Santa Fe, NM: Synergetic Press.
- Volkov, I.P. (1997). The noospheric approach to psyche. In V.V. Novikov, I.Y. Kiselev & V.V. Kozlov (Eds.), *Psychological pulse of modern Russia*. Moscow-Yaroslavl: International Academy of Psychology.
- von Bloh, W. (2006). Daisyworld: a tutorial approach to geophysiological modeling. *Impressum*, Potsdam Institute for Climate Impact Research. Retrieved February 27, 2010, from <http://www.pik-potsdam.de/~bloh/>
- Wackernagel, M., & Rees, W. (1996). *Our ecological footprint – reducing human impact on the Earth*. Gabriola Island, Canada: New Society Publishers.
- Wakeford, T. (1999). An early fan of Mother Earth from Mother Russia. *Times Higher Education*, 19 February, 1999. Retrieved February 27, 2010, from <http://www.timeshighereducation.co.uk/story.asp?storyCode=158971&sectioncode=34>
- Wanniski, J. (2005). Starvation and death in Niger. *The Conservative Voice*, August 06, 2005.
- Waters, O. (2005). *The shift: The revolution in human consciousness*. Infinite Being Publishing LLC.
- Web of Science. (2010). Retrieved February 3, 2010, from [http://apps.isiknowledge.com/WOS\\_GeneralSearch\\_input.do?product=WOS&search\\_mode=GeneralSearch&SID=3A1MbpiK25OCdjFJL87&preferencesSaved=](http://apps.isiknowledge.com/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=3A1MbpiK25OCdjFJL87&preferencesSaved=)
- Weiskel, T.S. (1997). Some notes from Belshaz'zar's feast. In J.E. Carroll, P. Brockelman & M. Westfall (Eds.), *The greening of faith* (pp. 11-29). Hanover, NH: University Press of New England.

- Westbroek, P. (2002). Biology on the global scale. *Nature* 419, 113-114.
- Where in the World is UNH? (2005). Where in the world is UNH? A University Dialogue on Globalization, 2005-2006. Retrieved February 3, 2010, from <http://www.unh.edu/academic-affairs/discovery/dialogue/2005/pdf/ud-05-06-complete.pdf>
- Wikipedia Encyclopedia. (2004). <http://en.wikipedia.org/wiki/Encyclopedia>, retrieved on February 3, 2004.
- Wikipedia Encyclopedia. (2009). Retrieved February 24, 2009, from <http://en.wikipedia.org/wiki/Polymath>.
- Wikipedia Encyclopedia. (2010). Retrieved March 25, 2010, from [http://en.wikipedia.org/wiki/Gaia\\_hypothesis](http://en.wikipedia.org/wiki/Gaia_hypothesis), [http://en.wikipedia.org/wiki/James\\_Lovelock](http://en.wikipedia.org/wiki/James_Lovelock) & <http://en.wikipedia.org/wiki/Utopia>
- Wilber, K. (1993). *The spectrum of consciousness*. Wheaton, Illinois: Quest Books.
- Wilber, K. (1998). *The marriage of science and soul*. New York, New York: Random House.
- Wudka, J. (2010). *Relativity, space-time and cosmology*. Retrieved March 19, 2010, from <http://www.scribd.com/doc/13727174/Relativity-SpaceTime-and-Cosmology-J-Wudka>
- Yanshin, A.L. (1989). Ecological Imperative. In T. Ilyina (Ed.). *On the Road to Noosphere: Prominent Soviet Scientists and Experts Hold a Round-table discussion on Major Problems of Environmental Protection* (pp. 10-33). Moscow, Russia: Novosti Press Agency Publishing House.
- Yanshin, A.L. (1993). To the Readers. In G.P. Aksenov (Ed.). *Vladimir Vernadsky: Biography. Selected Works. Reminiscences of Contemporaries. Opinions of Descendants*. Moscow, Russia: Sovremennik (in Russian).
- Yanshin, A.L. (2002). V.I. Vernadsky's teaching on the biosphere and the present. *Noosphere* 14, 27-31.
- Yanshin, A.L. (2007). Introduction. In *Geochemistry and the biosphere: Essays by Vladimir I. Vernadsky*. F.B. Salisbury (Ed.) (pp. xvii-xlii). First English Translation from the 1967 Russian Edition of *Selected Works*. Santa Fe, NM: Synergetic Press.
- Yanshin, A.L., & Yanshina, F.T. (1990). The scientific heritage of Vladimir Vernadsky. *Impact of Science on Society* 151, 283-286.

- Yanshin, A.L., & Yanshina, F.T. (1997). Preface. In V.I. Vernadsky. *Scientific Thought as a Planetary Phenomenon* (pp. 6-20). Moscow, Russia: Nongovernmental Ecological V.I. Vernadsky Foundation.
- Yanshin, A.L., Bebikh, I.G., & Yanshina, F.T. (Eds.). (1992). *Vladimir Ivanovich Vernadsky. Materials to Bio-bibliography of Scientists*. (2<sup>nd</sup> ed.). Moscow, Russia: Nauka. Retrieved February 13, 2010, from <http://www.tstu.ru/win/kultur/nauka/vernad/nasled.htm> (in Russian).
- Yanshina, F.T. (1993). V. I. Vernadsky's noosphere: An utopia or a real perspective, *Social Sciences and the Present*, 1: 163-173.
- Yanshina, F.T. (2000). V. Vernadky's noosphere: An utopia or reality? In V.I. Vernadskii: *Pro et Contra. Literature anthology of literature about V.I. Vernadsky for the last 100 years (1998–1998)*, (pp. 635–644). St. Petersburg, Russia: Russian Christian Humanitarian Institute (in Russian).
- Zelenyi mir. (2002). Federal Strategy of The Russian Federation's Sustainable Development. *Zelenyi mir 13–14* (1), 5–22 (in Russian).
- Zey, M.G. (2000). *The future factor: The five forces transforming our lives and shaping human destiny*. New York: McGraw-Hill, 2000.

## APPENDICES

## APPENDIX 1

### **Vladimir I. Vernadsky's English-language Publications**

- Vernadsky, V.I. (1923). A plea for the establishment of the biogeochemical laboratory. *The Marine Biol. Stat. of Port Erin. Ann. Rep.* 37, 38-43.
- Vernadsky, V.I. (1944). Problems of biochemistry II, *Transactions of the Connecticut Academy of Arts and Sciences* 35, 488-489.
- Vernadsky V.I. (1945). The Biosphere and the Noosphere, *Scientific American* 33 (1): 1-12.
- Vernadsky, V.I. (1986). *The biosphere*. Abridged translation of Vernadsky, V.I., 1926, *The Biosphere* (in Russian). Oracle, AZ: Synergetic Press.
- Vernadsky, V.I. (1997). *Scientific thought as a planetary phenomenon*. (B.A. Starostin, Trans.). Moscow, Russia: Nongovernmental Ecological V.I. Vernadsky Foundation..
- Vernadsky, V.I. (1998). *The Biosphere*. Full translation of Vernadsky, V.I., 1926, *The Biosphere* (in Russian). New York, NY: Copernicus Springer-Verlag.
- Vernadsky, V.I. (2007). A few words about the noosphere. In V.I. Vernadsky. *Geochemistry and the biosphere: Essays by Vladimir I. Vernadsky*, (pp. 405-417). F.B. Salisbury (Ed.). Santa Fe, NM: Synergetic Press.
- Vernadsky, V.I. (2007). *Geochemistry and the biosphere: Essays by Vladimir I. Vernadsky*. F.B. Salisbury (Ed.). First English Translation from the 1967 Russian Edition of *Selected Works*. Santa Fe, NM: Synergetic Press.



## APPENDIX 2

### **Vernadsky-Related English-language Publications** **that Accurately Transmit His Ideas and Historical Record**

- Abraham, R. (2009). Geochemistry and the biosphere: Essays by Vladimir I. Vernadsky [Review of essays of Vernadsky]. *World Futures*, 65(5), 436-441. Retrieved February 27, 2010, from <http://www.ralph-abraham.org/reviews/vernadsky.pdf>
- Bailes, K.E. (1990). *Science and Russian culture in an age of revolutions: V.I. Vernadsky and his scientific school, 1963-1945*. Bloomington and Indianapolis, Indiana: Indiana University Press.
- Balandin, R.K. (1979). *Vernadsky: Life, ideas, eternity*. Moscow, Russia: Znaniye (in Russian).
- Balandin, R.K. (1982). *Vladimir Vernadsky*. Outstanding Soviet Scientists Series. (A. Repyev, Trans.). Moscow, Russia: Mir Publishers.
- Behrends, T. (2005). The renaissance of V.I. Vernadsky. *Newsletter of the geochemical society*, 125, 8-14. Retrieved January 17, 2010, from <http://www.geochemsoc.org/downloads/gn125.pdf>
- Ghilarov, A. M. (1995). Vernadsky's biosphere concept: An historical perspective. *Quarterly Review of Biology* 70: 193-203.
- Grinevald, J. (1996). *Sketch for a history of the idea of the biosphere*, P. Bunyard (Ed.). Edinburgh: Floris Books.
- Grinevald, J. (1998). Introduction: The invisibility of the Vernadskian revolution. In V.I. Vernadsky, *The Biosphere* (pp. 20-32). New York, NY: Copernicus Springer-Verlag.
- Grinevald, J. (1998a). Vladimir Ivanovich Vernadsky (1863-1945): A biographical chronology. In V.I. Vernadsky, *The Biosphere* (pp. 151-158). New York, NY: Copernicus Springer-Verlag.
- Guegamian, G.V. (2006). Living matter and biospherology. In A.A. Cigna & M. Durante (Eds.). *Radiation Risk estimates in Normal and Emergency Situations* (pp. 35-46).

Dordrecht, Netherlands: Springer Netherlands. NATO Security through Science Series; Series B Physics and Biophysics 9.

Kauffman, G.B. (1991). Vladimir Ivanovich Vernadsky: Biosphere pioneer. *The World & I*, 10: p 316-323.

Lapo, A.V. (1988). *Traces of bygone biospheres*. Santa Fe, NM: Synergetic Press.

Lapo, A.V. (2001). Vladimir I. Vernadsky (1863-1945), founder of the biosphere concept. *Int. Microbiol.* 4: 47-49.

Lapo, A.V. (2002). Why to Paris? Report on the results of a business trip with indispensable comments. *Noosphere*, 14: 32-39.

LaRouche, L.H. (2001). *The Economics of the noosphere*. Washington, DC: EIR News Service.

LaRouche, L.H. (2005). The Vernadsky strategy. *Executive Intelligence Review*, February 18, 2005, 6-11. Retrieved February 3, 2010, from [http://www.larouchepub.com/eirtoc/2005/eirtoc\\_3207.htm](http://www.larouchepub.com/eirtoc/2005/eirtoc_3207.htm)

Levit G.S. (2001). *Biochemistry–biosphere–noosphere: The growth of the theoretical system of Vladimir Ivanovich Vernadsky*. Berlin: VWB-Verlag für Wissenschaft und Bildung.

Mochalov I.I. (1988). V.I. Vernadsky and religion. *Questions of Natural History and Technique*, 2: 36-44.

Naumov, G.B. (2005). From the fact to empirical generalization and scientific explanation (Methodology of V.I. Vernadsky). *Lithology & Mineral Resources*, 4 (1): 1-8.

Oldfield, J. D. & Shaw, D. J. B. (2002). Revisiting sustainable development: Russian cultural and scientific traditions and the concept of sustainable development. *Area* 34 (4), 391-400.

Oldfield, J.D. and Shaw, D.J.B. (2006). V.I. Vernadsky and the noosphere concept: Russian understandings of society-nature interaction. *Geoforum*, 37, 145-154.

Piqueras, M. (1998). Meeting the Biospheres: on the translations of Vernadsky's work. *Internatl. Microbiol.* 1, 165-170.

Rezvykh, P. (2004). George S. Levit: *Biogeochemistry–biosphere–noosphere: The growth of the theoretical system of Vladimir Ivanovich Vernadsky*. *HYLE--International Journal for Philosophy of Chemistry* 10 (1), 61-62,

- [http://www.hyle.org/journal/issues/10-1/rev\\_rezvykh.htm](http://www.hyle.org/journal/issues/10-1/rev_rezvykh.htm), retrieved on March 10, 2010.
- Smil, V. (2002). *The Earth's biosphere: Evolution, dynamics and change*. Cambridge, Massachusetts: The MIT Press.
- Snyder, D.P. (2010). *Geochemistry & the biosphere: Essays by Vladimir Vernadsky*. Retrieved March 7, 2010, from <http://www.synergeticpress.com/biospherics.html>
- Svirezhev, Y.M., & Svirejva-Hopkins, A. (2008). Biosphere: Vernadsky's concept. Noosphere. In S.E. Jørgensen & B.D. Fath (Eds.), *Encyclopedia of Ecology* (pp. 467-471). Oxford: Elsevier.
- Trubetskova, I. (2004). Vladimir Ivanovich Vernadsky and his revolutionary theory of the biosphere and the noosphere. Retrieved February 3, 2010, from [http://www-ssg.sr.unh.edu/preceptorial/Summaries\\_2004/Vernadsky\\_Pap\\_ITru.html](http://www-ssg.sr.unh.edu/preceptorial/Summaries_2004/Vernadsky_Pap_ITru.html)
- Trubetskova, I. (2009). Global ecological crisis: A call for a new, ecological and holistic worldview. In L. Andrianos, K. Kenanidis, & A. Papaderos (Eds.), *ECOTHEE: Ecological theology and environmental ethics* (pp. 427-442). Chania, Greece: Orthodox Academy of Crete Publications.
- Yanshin, A.L. (2002). V.I. Vernadsky's teaching on the biosphere and the present. *Noosphere* 14, 27-31.
- Yanshin, A.L. (2007). Introduction. In *Geochemistry and the biosphere: Essays by Vladimir I. Vernadsky*. F.B. Salisbury (Ed.) (pp. xvii-xlii). First English Translation from the 1967 Russian Edition of *Selected Works*. Santa Fe, NM: Synergetic Press.
- Yanshin, A.L., & Yanshina, F.T. (1997). Preface. In V.I. Vernadsky. *Scientific Thought as a Planetary Phenomenon* (pp. 6-20). Moscow, Russia: Nongovernmental Ecological V.I. Vernadsky Foundation.

## APPENDIX 3

### **Irina Trubetskova's Publications and Presentations on Vernadsky and His Theory of the Biosphere and the Noosphere**

#### **Publications**

Trubetskova, I. (2010). *From biosphere to noosphere: Vladimir Vernadsky's theoretical system as a conceptual framework for universal sustainability education*. Doctoral Dissertation, University of New Hampshire.

Trubetskova, I. (2009). Global ecological crisis: A call for a new, ecological and holistic worldview. In L. Andrianos, K. Kenanidis, & A. Papaderos (Eds.), *ECOTHEE: Ecological Theology and Environmental Ethics* (pp. 427-442). Chania, Greece: Orthodox Academy of Crete Publications.

Trubetskova, I. (2004). Vladimir Ivanovich Vernadsky and his revolutionary theory of the biosphere and the noosphere.  
[http://www-ssg.sr.unh.edu/preceptorial/Summaries\\_2004/Vernadsky\\_Pap\\_ITru.html](http://www-ssg.sr.unh.edu/preceptorial/Summaries_2004/Vernadsky_Pap_ITru.html).

#### **Guest Lectures**

Lecture "Global ecological crisis: A call for a new, ecological and holistic worldview" for *PHIL 450 Ecology and Values*, Dept. of Philosophy.

Two guest lectures for *NR444B The Real Dirt (Sustainable Agriculture)* (1) "Anthropocentric vs. ecocentric worldview: Does nature have an intrinsic value?" and (2) "Permaculture design: Science, philosophy and art of sustainable living," Dept. of Natural Resources and the Environment (NREN).

Lecture "Permaculture design: Science, philosophy and art of sustainable living" given to Horticultural Technology class *HT272 Landscape Design Studio*, Thompson School of Applied Science.

Lecture "Russia, the Soviet Union, and the destiny of my family in the 20<sup>th</sup> century" for *HIST664 Russia and Soviet Union in the Twentieth Century*, Dept. of History.

Lecture for *NR602 Natural Resources and Environmental Policy*: "Natural Resources

and Environmental Policy in Russia,” NREN.

Lecture “From Anthropocentrism to Egocentrism: Vladimir Vernadsky and his Revolutionary Theory of the Biosphere and Noosphere” given to the ***Permaculture Designer Certificate Course***, College of Life Sciences and Agriculture (COLSA).

Two lectures for ***NR401 Introduction to Natural Resources***: (1) “Human Values and Our Decisions about Environment” and (2) “Contemporary Environmental Issues in Russia,” NREN.

Two lectures for ***NR435 Contemporary Conservation Issues and Environmental Awareness***: “Conservation Issues in Russia,” NREN.

Two lectures for ***NR902 Ecological Values and Ethics***: (1) “Vladimir Vernadsky and his Revolutionary Theory of the Biosphere and the Noosphere” and (2) “Does Nature have an Intrinsic Value?” NREN.

### **International Conferences Presentations**

- 2009 A Global Forum – The 2009 Parliament of the Worlds’ Religions: “Make a World of Difference: Hearing Each Other, Healing the Earth” (Australia)
- 2009 Second International Conference of the European Forum for the Study of Religion and the Environment “Religion & Ecology in the Public Sphere” (Finland).
- 2009 New England Educational Research Organization (NEERO) Annual Conference (USA).
- 2008 Second biennial conference of the Association for the Advancement of Sustainability in Higher Education (AASHE) “Working Together for Sustainability – On Campus and Beyond” (USA).
- 2008 First International Interdisciplinary Conference “Ecological Theology and Environmental Ethics”, Orthodox Academy of Crete (Greece).
- 2007 North American Association for Environmental Education (NAAEE) Annual Conference (USA).
- 2006 International Symposium “Perspectives in Aquatic Ecology”, Max-Planck-Institute for Limnology (Plön, Germany).
- 2004 Northeast Campus Sustainability Summit featuring BIONEERS Satellite Telecast, UNH (USA).

### **Public Presentations**

- 2010      Lecture on “Science and Religion in the Age of a/the Sustainability Revolution: A Time for the Reunion?” NH United Church of Christ annual conference, February 20, 2010 (Pembroke, NH).
- 2009      Facilitator of the workshop “Science and Religion in the Age of the Sustainability Revolution: A Time for the Reunion?” given at the Permaculture Teaching Day (Barrington, NH).
- 2009      “Life in a Pond” (introduction of kindergarten and first grade students to the notion of a food chain and energy flow using *Daphnia* and microalgae as live examples) at the Earth Day , Horne Street Elementary school (Dover, NH).
- 2007      “Nature Working: Principles and Practices of Permaculture” presentation at the Day-long Permaculture Workshop given for public by Dr. Dave Jackie’s group at the University of New Hampshire.
- 2006      Facilitator of the workshop “Ecological footprint: Ever wondered how much ‘nature’ your lifestyle requires?” at the Art and Craft of Teaching Peace Conference, (Durham, NH).
- 2006      “Women’s Role in Preventing Global Ecological Crisis”, International Women’s Club, UNH.
- 2005      “Russian Connections to Buddhism,” Moebius Yoga Center (Durham, NH).
- 2005      “My Travels around the World: Evidence for Globalization”, International Women’s Club, UNH.
- 2002/03   “Russia in 20<sup>th</sup> Century”, Houghton High School, Michigan.

## APPENDIX 4

### A Sample 30-Minute Lecture Outline on Vernadsky's Biosphere and Noosphere:

#### An Application of Cognitive Theory Principles

GRAD931 Cognition, Teaching and Learning  
Irina Trubetskova's Final paper, Summer 2005

*Lecture presentations need to trigger in students the types of processes known to enhance the encoding and subsequent retrieval of the information that is to be learned.*

deWinstanley and Bjork, 2002

#### **An Outline for a 20-30 minute Lecture**

*(An example of the application of cognitive theory principles for classroom instruction)*

**General notes:** Generation of an effective 20-30 minute lecture is a challenge for an instructor because of the limited time to convey the desired information and to transform it, using cognitive theory principles, into knowledge. It has both pluses and minuses for the instructor. The obvious advantage of this short-term lecture is that it does not surpass students' potential to sustain focused attention (20-35 min), and the instructor could use the whole period of time available very effectively. The disadvantage of this short-term class is that due to the lack of time (1) it is difficult to cover profoundly a substantial amount of information, and (2) it is almost impossible to use in full measure active learning techniques (e.g. small-group work, extended class discussions, in-class writing activities such as interrogating for elaboration and writing summaries). Therefore, careful organization, structuring, and especially timing of this kind of lecture should be of a special concern for an instructor, as well as striving for incorporating active learning strategies into his/her class (in order) to produce an actually interactive lecture.

**Approach:** When generating this lecture outline, I was guided by the cognitive information-processing principles we learned in the GRAD961 course "Cognition, Teaching and Learning". The above quote from deWinstanley and Bjork (2002) reflects the overall idea, and I tried to incorporate in the extended lecture outline some basic components of effective processing, such as attention, interpretation, elaboration, generation, and retrieval practice. My interpretations on the use of the strategies of presenting information that induce effective processing by students are shown in *Italics*.

**Title:** Introduction to the Biosphere and Noosphere Theory of Vladimir Vernadsky

**Topic:** This is an introductory lecture to the vast topic on the theory of the biosphere, which will be covered during several subsequent classes and will consider in detail (1) historical perspectives, (2) Vladimir Vernadsky's revolutionary Theory of the Biosphere and the Noosphere in details, and (3) its importance and contemporary applications

**Objectives:** To familiarize students with (1) Vernadsky's theory of the Biosphere and the Noosphere in a general way and (2) its importance for the progress of scientific and philosophical thought in the 20<sup>th</sup> century and for the sustainable development of humanity; (3) as a measure to evaluate whether the tasks were accomplished for this lecture, at the end of the class students will be asked to formulate the definitions of the biosphere and the noosphere, in one sentence each, to give the name of the creator of the Biosphere and the Noosphere Theory, and draw a concept map of the Earth system.

**Format:** combination of a lecture and discussion class, using (1) visual demonstrations, i.e. PowerPoint slides, (2) and active learning techniques, such as a 5-minute period working in small groups at the first quarter of the class and a 5-minute period of individual writing at the end of class, for enhancing effective encoding of the material to be learned in this class.

### ***INTRODUCTION TO THE BIOSPHERE AND THE NOOSPHERE THEORY OF VLADIMIR VERNADSKY (Outline of the 30- minute lecture)***

#### **The first 5 minutes**

**Slide 1 – The title of the presentation** is projected on the screen while students take seats and stays until the next slide is shown. *Thus the topic is exposed for the **first 5 minutes** and serves as **an advanced organizer** (i.e. material introduced in advance of the material to be learned). People are biased with the context – for example, in the GRAD961class we read the same story titled differently and remembered the same information selectively depending on the **title, i.e. context announced**.*

*(1) I start class with the following questions, knowing students' answers beforehand. By these questions, which serve as **advanced organizers**, along with the exposed title, students will be intrigued and prepared to grasp the following material; this will also focus their **attention** - one of the most crucial components of the **effective processing of information** - from the very beginning). **Pre-questioning** is effective because it targets information you want students to learn:*

- **Question 1:** Do you know who Vladimir Vernadsky is? – NO.
- **Question 2:** Do you know what the noosphere is? – NO.
- **Question 3:** Do you know what the biosphere is? – YES.



*Here I incorporate elements of **active learning** and suggest students **work in small groups of 3-4 students** if this is a small/medium class, or I propose to discuss this issue with a neighbor in a big class. They are to discuss and give a definition of the biosphere in one sentence within **3 minutes**. During the next **2 minutes**, I let representatives of small groups (or some volunteers in a large class) to formulate the definition of the biosphere, which I expect to be wrong or incorrect. There is a very small probability that someone will come up with the correct definition of the biosphere (if so, I congratulate him/her). In any case, students will be eager to know what the term biosphere really means and how it is understood by modern science – a good time to consider historical perspectives of the development of the concept of the biosphere.*

(2) I emphasize that the term biosphere became a common word in our time and is widely used, but not many people know when and who coined the term. So my next question is:

- **Question 4:** *Do you know who coined the term biosphere and when? Of course, they do NOT know.*

### **The next 15 minutes**

***Lecturing** with the assistance of **PowerPoint** slides for visual demonstration: “PowerPoint is just a [powerful] tool” and “rarely a good method” of presentation (Tufte, 2003); however, the presenter should be very careful not to misuse it to avoid failure. Good use of PowerPoint does not contradict “the core ideas of [good] teaching – explanation, reasoning, finding things out, questioning, content, evidence, credible authority” (Tufte, 2003). I use PowerPoint as an illustrative assistance, a visual stimulation to make my objectives, the material to be learned, and the overall presentation more clear. I see visual support as a means to enhance students’ attention, understanding, memory and organization, i.e., as a device to empower effective processing.*

**Slide 2 – With a portrait of Austrian geologist Eduard Suess (1831-1914)** projected on the screen, I tell that Suess coined the term *biosphere* in 1875 in order to discuss various envelopes of the Earth in his paper about the genesis of the Alps. In his interpretation, biosphere was an envelope of life that “is limited to a determined zone at the surface of lithosphere”. However, the term was never given a definition or elaborated upon until Vladimir Vernadsky created the theory of the biosphere.

*In the previous slide and the next one, I expose portraits of the prominent scientists and simultaneously tell students about their achievements. **These visual demonstrations** serve as a tool to enhance encoding while I am telling about their achievements (“**the multimedia principle**: students learn more deeply from multimedia presentations involving words and pictures than from words alone”, Mayer, 2002).*

**Slide 3 – A portrait of Vladimir Ivanovich Vernadsky (1863-1945)**, a great 20<sup>th</sup> century researcher and thinker, a creator of the theory of the biosphere. I tell that

Vernadsky was the “the last naturalist”, a unique figure in the extremely specialized science of the 20<sup>th</sup> century. His research ranged from meteorites and cosmic dust to microbiology and migration of microelements via living organisms in an ecosystem, and resulted in publication of 416 works during his life, most of which became classical scientific papers in many fields. His work served as a foundation for the creation of the new branches of science such as radiogeology, cosmochemistry and biochemistry and predetermined the appearance of new disciplines like earth system science and environmental philosophy, global ecology, environmental science and conservation. Vernadsky's ideas, for example, underlie in the sustainable development concept under the aegis of the United Nations. Numerous volumes of his writings and materials were published after his death, and this work is still going on.

**Slide 4 – “It is essentially Vernadsky’s concept of the biosphere... that we accept today”** - I project the words of the founder of the Yale school of ecology, Evelyn Hutchinson (1903-1991) and give the definition of the biosphere (*signaling by increasing volume of my voice that this is an important information and letting them write it down*):

- **Biosphere is the totality of living organisms (= biota) with their environment.** I emphasize that there is need to clear up the confusion that still exists in the understanding of this term, even among some scientists and educators (not to mention the ordinary, unsophisticated people) who mostly misinterpret the biosphere as a totality of living organisms (without their environment). *I repeat again the proper scientific definition of the biosphere to allow students to better memorize it, i.e. I apply a **spaced repetitions’ strategy within the lecture**, which is a powerful method of enhancing effective processing.*

**Slide 5 – The fundamental principles of the Biosphere Theory.** I tell that Vernadsky developed a complete theory about the Biosphere as a planetary and cosmic phenomenon. His theory contains a number of basic principles, some of which are shown below. *While speaking, I expose them one after another – using the **layering slides method** in PowerPoint so that when each subsequent bulleted point comes on separately (appears on the screen), I let students write it down. After students have written down the given point, I linger on it asking questions (which makes the **lecture interactive**) and giving my short, explanatory comments on each of the below lines to make the **material meaningful by relating it to prior knowledge**:*

- The boundaries of the biosphere
- The difference between living and non-living matter
- The total mass of living matter
- The amount of cosmic energy that is absorbed by the biosphere through trapping of solar energy by chlorophyll of green algae
- The cycles of chemical elements passing through living organisms of the biosphere.

**Slide 6 – The envelopes of planet Earth.** Thus, I continue, as early as at the beginning of the 20<sup>th</sup> century, Vernadsky considered the Earth as a system consisting of several interacting envelopes (subsystems).

- **Question 5:** What envelopes of the planet Earth do you know?

*I expect that students could name at least some of them (atmosphere, hydrosphere, lithosphere, and biosphere) and together, we are trying to identify all of them (**interaction, interpretation**). It is also the right moment to refresh their attention as time is approaching the limit of the active attention period. **Asking questions during a lecture** is a powerful technique that allows keeping students alert and focused, provides structure, and makes class interactive). After that, for better memorizing, I project short definitions of Earth envelopes on the screen as we switch from one to another. By highlighting some words spoken in a louder voice, I am letting students know what information is important (**signaling principle**) and allowing them to write it down (one at one time as the given bullet point is exposed):*

**Atmosphere** – the air envelope surrounding the Earth.

**Hydrosphere** – the water envelope surrounding the Earth.

**Lithosphere** – the outer solid shell of the Earth.

**Biosphere** – the totality of living organisms with their environment.

*And here again, for better encoding, I repeat the definition of the biosphere in another way (i.e. I repeat the information to be learned in different words because **spacing repetitions** of key information within and across lectures enhances the efficiency and productivity of students' processing of this information):*

**Biosphere** is all those layers of the Earth and the Earth's atmosphere in which living organisms are located.

**Slide 7 – A diagram of the Earth as a system** is represented by the overlapping spheres of the Earth. *This is an example of a graphic organizer, in particular a **Venn diagram** that tells about the nature of relations between elements, i.e., **relation among ideas is captured in a picture**); each sphere appears on the screen in sequence - one after another. This is an example of the **layering method in PowerPoint**, which poses a reinforcement value when students can anticipate next slide. The overlapping spheres finally form a diagram of the Earth as a system, i.e. **concept map** that serves as a **graphic organizer** for illustrating the relationship between different components within one system, and facilitates the encoding of the complex information of today's lecture by making it explicit. Indeed, "according to the cognitive theory of multimedia learning, **deeper understanding occurs when students mentally connect pictorial and verbal representations of the explanation**" (Mayer, 2002).*

I comment in a few words on each of the spheres as they appear on the screen in sequence (**rehearsal and repetition** are crucial for memorizing and should be **meaningful**, that is related to what students already know; **meaningful information is easier to hold**), with emphasizing that the biosphere is a unique envelope that possesses life and penetrates all other spheres. I tell that Vernadsky's view of the planet Earth as a system of interacting components is exactly how Earth is understood now by a new discipline, Earth System Science, that emerged at the end of the 20<sup>th</sup> century.

**Slide 8 – Publication of Vernadsky’s *Biosphere*.** I explain that Vladimir Vernadsky elaborated on the concept of the Biosphere as a planetary and cosmic phenomenon during the first quarter of the 20th century. His concept of Biosphere was expounded in his book “The Biosphere” published in Russian (1926) and French (1929) (*while telling this, I provide visual information to make a comparison possible, projecting one line after another – i.e. applying the layering method of visual demonstration*):

**Russia - Biosfera (Биосфера), 1926 (200pp.)**

**France - La Biosphère, 1929**

**USA - The Biosphere, 1986 (abridged translation)**

**- The Biosphere, 1998 (first full English translation)**

While displaying the above information in sequence, I emphasize that Western scientists received an opportunity to read the English translation of Vernadsky’s *Biosphere* only in 1986 (abridged version, though), i.e. 60 years after the first publication in Russian or 57 years later than in French. Finally, the first full English translation of *The Biosphere* saw the light only in 1998.

**Slide 9 – The Vernadskian renaissance...** I tell that, paradoxically, Vernadsky’s ideas for more than half of a century invisibly and organically penetrated many fields and branches of modern science, without his name being put forward. These ideas predetermined the appearance and influenced the development of such important disciplines as biogeochemistry, global ecology, environmental science, and Earth system science.

Only in the end of the century was the value of Vernadsky’s ideas fully understood and after years of silence, the West finally started to discover and scientifically recognize the creative genius of Vernadsky reflected in the biosphere concept. *I read aloud some of the below references of Vernadsky’s outstanding achievements in science given by prominent contemporary scientists and researchers in recent years; in the process of doing this, I project some of these opinions using the layering method. Although students’ attention is divided (as they attend simultaneously to what I say and the information on the screen) and it is optimal to have no more than 3-5 bullet points on one slide, in this particular case the visual support helps students to see who gave these evaluations and when, which will make the information conveyed more convincing:*

- *The Vernadskian renaissance...The international revival of Vernadsky... Vernadsky’s scientific revolution* (Grinevald, 1998)
- *A principal architect of our contemporary ecological vision of the biosphere* (Engel, 1990)
- *His name is as inseparably linked with the biosphere as Albert Einstein’s name is with relativity* (Kauffmann, 1991)
- *The originator of the modern theory of the Biosphere* (Grinevald, 1998)
- *What Charles Darwin did for all life through time, Vernadsky did for all life through space* (Margulis et al., 1998)
- *One of the greatest thinkers of history and philosophy of science* (Levit, 2001)

- *The scientist who elaborated the concept of the biosphere and who is now generally acknowledged as the originator of a new paradigm of life studies (Smil, 2002)*

*To emphasize the significance of Vernadsky's contribution to modern science and the overall worldview, I increase the intensity of my voice to draw more attention and avoid monotony (i.e. **signaling**) when pronouncing, for example, such words as "renaissance", "revolution", "principal architect", "Albert Einstein" and "Charles Darwin", "originator of a new paradigm in history and philosophy of science".*

**Slide 10 – Image of Earth from space:** *I let students relate their familiar visual information to what I am saying below, i.e., to the new information; **meaningful information** (i.e., information that relates to something people already know) is easier to hold. In this particular case, the image serves as an **advanced organizer** not only in the **facilitating recall** (which is usually its typical function), but also in promoting "connections between prior knowledge and to-be-learned material" (Corkill, 1992)*

The most amazing thing about Vernadsky is his approach to the biosphere as a planetary and cosmic event – a new way of looking at the Earth – as if he observed the Earth from space, although exploration of space started significantly later. Indeed, the first satellite, *Sputnik* (USSR), was launched only half a century later, in 1957, and the first cosmonaut, Yuri Gagarin, became the first human in the history of mankind to see the planet Earth from space in 1961. It is not surprising for us to see images of our planet taken from space, but for Vernadsky it was impossible.

I wonder what grand and dynamic pictures Vernadsky envisioned, as early as in the beginning of the 20<sup>th</sup> century, when he came to the understanding that the biosphere, in fact, was a great geological and cosmic force, changing the face of the unique, living planet Earth through space and time.

*By providing students with **actual visual image** of Earth from space, and simultaneously verbally wondering what pictures Vernadsky could have envisioned a long time before the coming of the cosmic era (when these images became available), I encourage students to form spontaneously **interactive mental images**, i.e., they spontaneously are engaged in the processes of **interpretation and elaboration**.*

**Slide 11 – The Noosphere.** I tell that Vernadsky, looking far ahead, predicted the coming of the new phase in the evolution of the biosphere and defined it as the Noosphere, the sphere of reason or intelligence. I project the definition of the Noosphere:

- **Noosphere (from Greek "sphere of intelligence") is the envelope of mind or the sphere of human thought, reason, and intellect.**

I continue that Vernadsky considered the emergence of the Noosphere as a critical evolutionary step needed for preserving and reconstructing the biosphere in the interest of humanity as a single entity. According to Vernadsky, the noosphere is a new evolutionary stage of the biosphere, when human reason will provide further sustainable development both for humanity and the global environment (***interpretation** of the new term that occurs when new information is related with what is already known*).

**Slide 12 – An Image of the title page of Vernadsky’s paper “The Biosphere and the Noosphere” in *American Scientist* (1945):** I tell that Vernadsky believed in human reason and that it will rule the world in the future, and made a number of predictions about the noosphere. In his paper “The Biosphere and the Noosphere” in *American Scientist* (1945), Vernadsky considers the particular features that will mark the dawning of the new era – the Noosphere.

**And here is your HOMEWORK for the next class** (I am *signaling* students by my voice, although the word “homework” itself is a good signal to make them alert and sharpen their attention). I repeat that Vernadsky believed that we, as humanity, are entering **the noosphere** – the new evolutionary stage in the history of the Earth and the biosphere when human reason will rule all aspects of life on Earth (*spaced repetition*). Vernadsky made a number of predictions about a new incipient phase in biospheric evolution - the noosphere, and here is **your homework**: (1) read his “The Biosphere and the Noosphere” paper in *American Scientist* (1945), which is available at the UNH library, and (2) make a list of the predictions he made about the Noosphere (*by doing this, students will be engaged in the process of generating information which is a power method of learning*); (3) be ready to discuss whether Vernadsky’s predictions about scientific, social, and technological progress of humanity were correct and give some modern examples for support (*interpretation and elaboration, the important components of effective learning, will be triggered through establishing interconnections with other, known information; this assignment assumes active reading and making new information personal by relating it to their own life, i.e. elaboration of new information with examples that are meaningful to them*). I say that next time, we will discuss in class these predictions about the upcoming Noosphere and if they became true.

**Slide 12a – Vernadsky’s optimism about the future of humanity and Earth.** *I end the lecture on an optimistic note. I find it important to raise students’ spirit because the surveying of undergraduate students at UNH shows that a lot of young people are very pessimistic about their own and our planet’s future. This is also an example of the strategic placement of enthusiasm as a mnemonic technique, which activates students’ attention and in combination with the projected image, enhances effective processing.*

I project the beautiful face of the elderly Vernadsky and his words to the preamble of his paper in *American Scientist*, “The Biosphere and the Noosphere” (1945):

***“I look forward with great optimism. I think that we undergo not only a historical, but a planetary change as well. We live in a transition to the noosphere. Cordial greetings, V. Vernadsky.”***

### **The last 10 minutes**

***Answering questions from students (5 minutes):***

If there are no questions or some time is left, I will tell them a short and good-humored story just to show Vernadsky’s amazing personality (*which I want them to know and which is the focus of the joke. I have a number of funny and striking stories on hand to*

*illustrate my key points for the next lectures. Application of humor serves as a **mnemonic device**, i.e. a technique that assists memory. Also, as students' capacity to sustain an **active attention** is almost exhausted after 20 minutes of class, it is a good moment to shift their attention to another activity and refresh their **attention** by entertaining them with a joke (= "a squirrel").*

### ***Conclusion of the class (the last 5 minutes – in-class writing assignment):***

For the 5 minutes left, I provide students with a handout and suggest to them – without usage of their notes – to formulate in one sentence (1) the definition of the biosphere and (2) the definition of the noosphere, and answer two questions: (3) who is the creator of the theory of the biosphere and the noosphere, and (4) what envelopes surround the Earth (draw a concept map for the response).

*By doing this, students are engaged in the process of **active encoding** of the material covered in this class through: **spaced repetition of the key material within lecture in the form of testing, generation and retrieval practice**. Answering questions at the end of the class (i.e. **recalling** key information I planned for them to learn during this class) serves in fact as "**summary writing during lecture** [which] results in more durable learning" (Davis and Hult, 1997) and is beneficial for later recall because this is a process of generating data. All these techniques are supposed "to trigger in students the types of processes that result in durable encoding of the concepts, facts, and ideas covered in the lecture – encoding of the type that will survive beyond the lecture period" (deWinstanley and Bjork, 2002).*

### **Final Remarks**

My task for this particular class is accomplished. We will return to the material and main ideas, introduced in this class, several times again during the semester but from different standpoints and in multiple contexts. Spaced repetitions of key information provide structure not only within a lecture, but apply to the overall structure of the course to facilitate encoding and to ensure that students will finally grasp all the main concepts, terms, and ideas to be learned in this course. Indeed, "spacing multiple opportunities to study, learn, and be tested on information over time is a powerful method of enhancing effective processing" because "long-term recall is enhanced by distributing rather than massing the presentations of to-be-remembered information" (deWinstanley and Bjork, 2002). In order to enhance long-term retention and what is especially important – the generalization of knowledge, I am going to **maximize not only spacing, but also encoding variability**. I will consider the key concepts of the biosphere and the noosphere from different perspectives, with the intense application of different mnemonic techniques that assist memory and enhance effective processing (e.g., analogies, humor and strategic placement of enthusiasm, visual images and mental imagery); I also will use elaborative interrogation both in the form of active learning during the lecture and outside the class (e.g., active reading, writing essays).

I agree with our instructor of this course, Dr. Edward J. O'Brien, that it is not beneficial to provide students with **instructor's outlines** of the lectures. Therefore, I will encourage

students to take **notes** (instead of handing out outlines) for making the process of learning more effective and facilitate students' note taking "by **highlighting** important information and providing a clear organizational framework" (Carrier, 1983; Mayer, 2002). However, it makes full sense to supply students with a copy of a complex concept map or diagram so that they could elaborate on it and make personal notes during the narration of the material.

As many students are lacking effective study skills, I will familiarize them with **strategies of effective learning** and, through appropriate organizational structure and practice (Driscoll, 2005; Kiweira, 2002; Weinstein and Meyer, 1991), will enable them to acquire the proper self-regulatory skills.